Help

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Introduction

BUSMASTER Overview

BUSMASTER is a user friendly and cost effective testing and development tool for CAN bus systems that runs on Windows 2000, Windows XP and Windows 7. It helps in monitoring, analyzing and simulation of CAN messages the bus. Using its powerful functions and user-programmability one can simulate CAN system of any complexity.

Additionally it provides options to analyze data bytes in raw data format or logical/physical data format and signals can be monitored separately. These two functionality is achieved using a message database. An in-built database editor is provided to create message databases.

The user can simulate a CAN node's behavior or enhance the functionality of BUSMASTER. This is done by means of 32 bit windows Dynamic Link Library (DLL). A DLL containing BUSMASTER interface can be loaded dynamically to simulate the node's behavior. An in-built Function editor is provided to write program in ANSI C and build a DLL. Once DLL is generated, it can be loaded and used dynamically.

There are many others features that can be used without any programming. The key such features are

- Display of messages,
- Message information and Interpretation,
- Filters,
- Logging,
- Replaying logged messages,
- Network statistics,
- Different time stamping,
- Interactive transmission of message blocks,
- Signal watch etc.

To facilitate the user programming a comprehensive set of APIs and event handlers are provided.

Key Features

- Using USB port multiple USB CAN hardware can be connected and monitored with multiple instances of BUSMASTER application.
- It operates in Active mode. In active mode the tool influences the bus. In passive mode the tool does not have any influence on the bus.
- It supports CAN 2.0A and 2.0B protocol.
- The messages can be displayed in decimal or hexadecimal format.
- There are three different time stampings namely system time, relative time and absolute time mode. The absolute time is the time from when tool is connected to CAN bus. The relative time is time between two consecutive messages if the display is configured in scroll mode. In overwrite mode it is the time difference between two messages of same ID. Time stamping is done at CAN driver level. The system time is PCs real time value.
- User can log messages to a file and replay the logged file. The time stamping mode can be also be configured in System, Relative and Absolute mode during logging. The replay can be selectively done for transmitted, received and all messages. More then one logging session with same time stamping can be combined in a single replay session. The replay can also be configured in a cyclic manner with different time delay.
- The message filtering can be done through Software, hardware or both. Software filter works at application level while hardware filter works at CAN controller level.
- It supports transmission of message blocks in single shot or periodic mode with time/key trigger.
- It can display messages and error frames on CAN bus.
- User can configure acceptance filter, baud rate and warning limit. Warning limit is not supported currently by BUSMASTER with USB interface.
- Message display can be configured in different colours. Different colours can be assigned to different message IDs. Message display entries and the display update rate can be configured.
- It provides a message database editor for creating & editing of messages and its signals.

- The signals of message can be interpreted. It can be interpreted in a separate window or on message display window.
- Signals alone can be monitored separately with time stamping.
- It provides programming facility through Function editor. The event-based programming is done using ANSI C language. The user can use all windows provided APIs and any third party LIB/DLL/API files.
- It supports all bit rates up to 1 MBPS.
- User can analyse of bus statistics.
- User preferences can be saved or loaded. The last saved user preferences are loaded automatically at the start of application.

What is new?

2.6.4

Following features are added:

- Advanced log file settings
- Replay optimization for CAN
- Node Simulation UI Improvement
- Toolbar cleanup

2.6.3

Following features are added:

- Support for LIN Kvaser
- Bug Fixes

2.6.2

Following features are added:

- Bug Fixes

2.6.1

Following features are added:

- Support for FlexRay GIGATRONIK flex-i Controller.
- Bug Fixes

2.6.0

Following features are added:

- LIN Database editor (LDF)
- Introduction of CMake for solution/project file generation

2.5.0

Following features are added:

- BLF to LOG Conversion
- Bug Fixes

2.4.0

Following features are added:

- LIN PEAK device support
- LIN Master mode
- LIN Status message reporting
- ISO-TP over CAN support
- UDS support
- Bug Fixes

2.3.0

Following features are added:

- LIN Statistics window
- LIN Signal watch
- LIN Filters
- LIN Message window configuration
- LIN Diagnostic ID support (3C and 3D)
- FlexRay ETAS BOA support for BOA 2.0 AND BOA 1.4

- Bug Fixes

2.2.0

Following features are added:

- Support for LIN ETAS BOA
- Support for LIN logging
- Support for BOA 2.0 for CAN and CANFD
- Bug Fixes

2.1.0

LIN support added for slave node functionality. The tool can be used to respond back to master requests. It supports the following features :

- Support for LIN v1.3 and v2.0
- Added LIN support for Vector XL library
- LDF importing for cluster configuration and message interpretation
- Modified Tx Window for DB and Non-DB frame configuration and data updation
- Message Window with Error information and interpretation
- Node Simulation for slave mode with message, timer, key and error handlers

2.0.0

Added Support For Following CAN Controllers:

- ETAS ISOLAR EVE CAN

Added FlexRay Support For Following Controllers:

- ETAS BOA

Added following FlexRay Modules:

- FIBEX Import support for 2.0,3.0
- Message Window
- Transmit Window

Added LIN Support for Following Controllers

- ETAS ISOLAR EVE LIN

Added Following LIN Modules:

- Message window
- Transmit Window

1.9.0

Support to following hardware interfaces are added:

- NSI interface
- i-View Interface
- Development Environment IDE is migrated to Visual Studio 2012
- Visual Studio Redistributable Package is expected by the installer script. Please refer development environment for more information

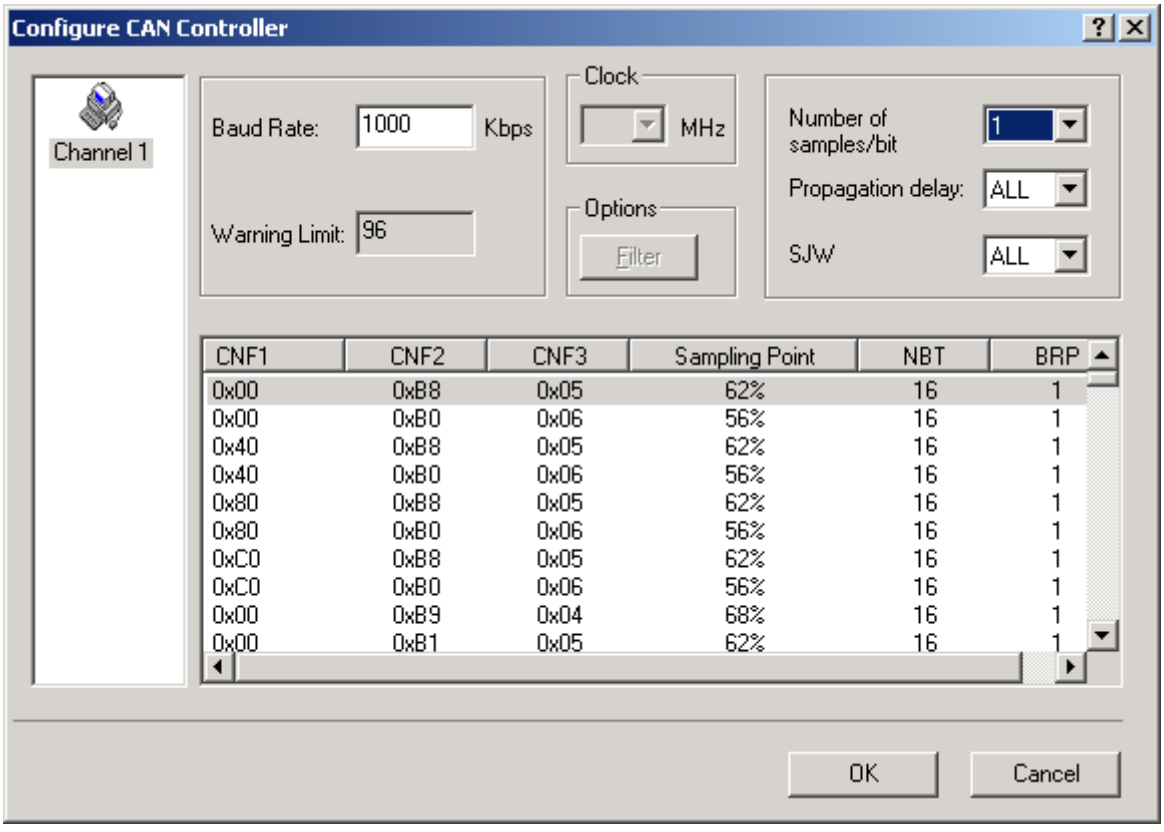
Getting Started

If you are using BUSMASTER application for the first time then the following section will help you to get familiarized with the features of this tool. For this we will operate the BUSMASTER in self-reception mode i.e. the BUSMASTER tool will be the sender and receiver of CAN messages.

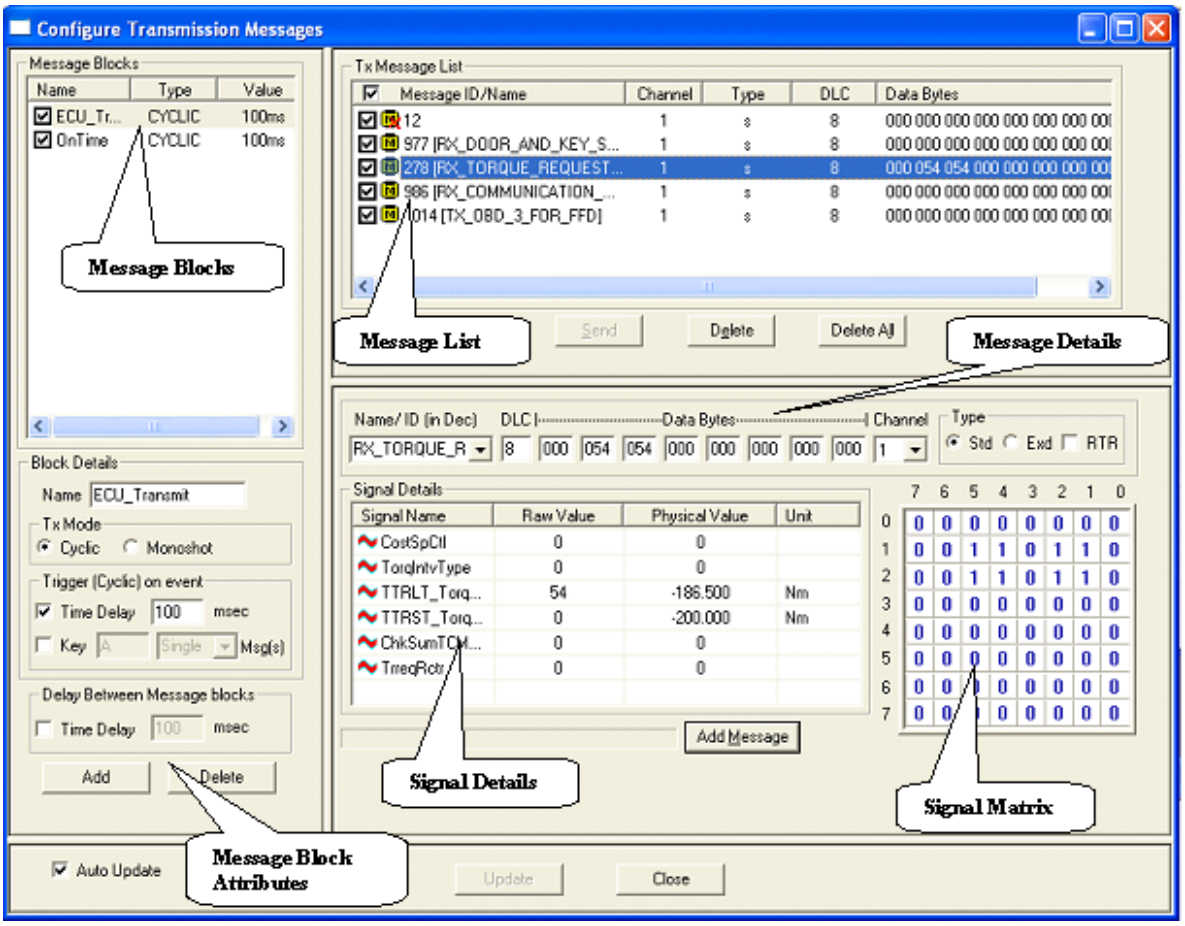
Initial Setup

- Call BUSMASTER.exe by double clicking the appropriate icon in the BUSMASTER program group.
- The tool will only work with Active mode. Make sure that the USB hardware is connected to the PC and CAN bus.
- For setting the Baud Rate (a.k.a. Bit rate), go to Hardware menu and select Channel Configuration. This brings up a dialog box as shown in figure 1. Enter the required baud rate in the Baud Rate field.

  Other than the baud rate values this dialog can be used to set other parameters like sampling point, Synchronization jump width, Hardware acceptance code, mask and warning limit.



  - In USB interface, setting Warning limit is not supported. The default warning limit value 96 is set internally and user cannot change this value.
  - Dual filtering is not supported in USB interface. Only single filtering is supported.
- To send CAN messages, the messages has to be defined first. For this select Transmit menu under CAN menu and select Configure menu. A dialog as shown below pops up.



- You can add a total of 32 Message Blocks having trigger condition either as “On Key” or “On Time” or both. Each block of message can have a total of 64 messages.
- You can activate any message block selectively for transmission by selecting a check box in Message Blocks list.

Message can be added that are not in the database as well as in the database. For details about this refer Transmit Message(s)

From the same dialog box one can select the time interval between two consecutive messages by entering the delay value in milliseconds in the Interval box. The Key box is used to enter key value for key trigger. The transmission can be configured as one shot or cyclic by selecting or deselecting the item Monoshot.

Close the dialog by clicking on OK button. You can use Apply button to save the changes without closing the dialog.

User can also select the message from the list and transmit over the CAN bus by using Send button or by right click in the list and selecting the Send menu. Message blocks and messages in blocks can be added/deleted by selecting the menus. The pop up menu is displayed when user right clicks the corresponding list.

The message details can be modified even the transmission is in progress. Message data can be directly modified by changing the data byte values or the signal values. Signal values can be given as raw value or physical value. In all these cases all other values will be updated accordingly. You can modify the message details and select Apply or OK button to reflect the changes for transmission. During transmission you can’t modify the details of message block which is active. But you can add a new block or change the message block details for block, which is not active.

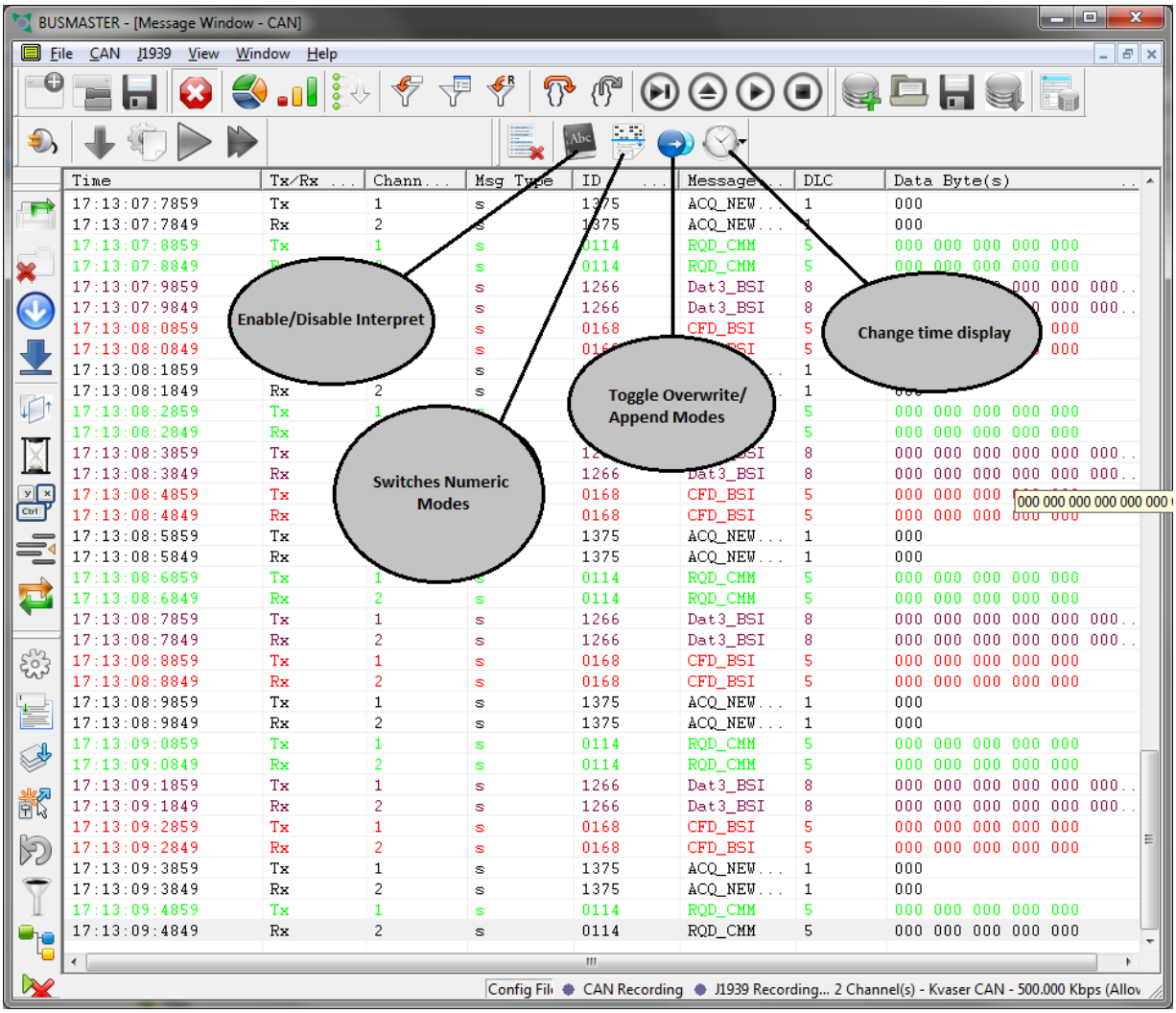
On selection of start transmission only those blocks which is active having at least one message frame will be transmitted. Also if the trigger is selected as On Key then the transmission will start when the corresponding key is pressed.

Now the messages to be transmitted have been configured and it’s ready to be transmitted.

- Select the Connect menu from the CAN menu option. This initializes the CAN controller.
- To initiate the transmission of the messages go to the menu **CAN --> Transmit --> Enable**.

A cross mark on the message icon in the Tx Message list indicates that the message is not available in the database.

If the installation is proper and working then you should be able to see the configured messages being transmitted and receive simultaneously in the Message display window as shown in below



Operating Modes

The BUSMASTER can be operated in Active mode

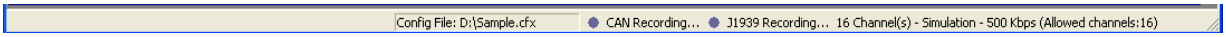
- Active: In this mode the controller will participate in the bus activity i.e. it will generate acknowledgement signal, error signals etc on reception of message and also will be able to transmit messages.
- Passive - Currently this mode is disabled.

Any one of the above mentioned modes can be selected from the menu **Hardware --> Driver Mode**.

By default BUSMASTER will be in Active mode.

Status Bar

The status bar gives the following information



- The first pane shows the loaded configuration file path.
- The second pane displays the data logging status for CAN and J1939
- The extreme right pane indicates the hardware selected, baud rate and the number of channels supported by the application.

Note:

- Error Counters values and controller status are displayed in Network Statics window.

General

Configuration settings in a file

User can save your preferences of the tool into ".cfx" file. The last loaded configuration file will be loaded automatically when the tool is run for the next session. If the configuration file is not found then, the application will load the default configuration settings and the status of the loaded configuration filename will be shown on the status bar.

Creating New Configuration file

1. Select **File --> New** menu option. This will invoke file Save dialog box.
2. Enter the new configuration file name. And select Save button. The new configuration file will be loaded and the same filename can be seen on the status bar.

Loading a Configuration File

1. Select **File --> Load...** menu option. This will invoke file Open dialog box.
2. Select the configuration file name. And select Open button. The selected configuration file will be loaded and the loaded configuration file will be displayed in the status bar. The same configuration file will be displayed on the top of MRU configuration file list (**File** > **Recent Configuration**).
3. Selecting a configuration file name from the MRU list will also do loading of the configuration file. If load is successful then the same configuration file will be displayed on the top of MRU configuration file list.

Note:

- While loading BUSMASTER with parallel port interface created configuration file in to USB interface, checks have been made to find unsupported options. If anything found user will be informed about that and BUSMASTER will changes those values to default internally. These changes will not be saved unless the user selects File Configuration Save. Configuration file created in BUSMASTER with USB interface can be loaded in to BUSMASTER with Parallel port interface.

Saving a configuration file

1. Select **File --> Save** menu option. This will invoke File Save dialog box.
2. Select the configuration file name. And select Save button.
3. The selected configuration file will be saved. The same configuration file will be displayed on the top of MRU configuration file list (**File** > **Recent Configuration**).

Saving a configuration file with new name

1. Select **File --> Save As** menu option. This will invoke File Save As dialog box.
2. Enter new configuration file name. And select Save button. The selected configuration file will be saved.

If the loaded configuration file is changed during the usage of the tool, a save confirmation message is displayed to the user before closing the application.

CAN

Introduction

Configuration

BUSMASTER has provision for configuring the following properties

- Baudrate: By default the tool is configured to operate at 100kbps. This can be changed to any valid value between 5 kbps and 1000 kbps.
- Acceptance Filter: To increase the response of the tool at very high messages rate one can set the acceptance filter. The controller filters the messages based on the values set for acceptance code and mask. This filtering is faster than the software filter (App filters).
- Warning Limit: One can monitor the condition of the network by setting a warning limit value. The user will be notified when either one of the error counter (Tx & Rx) exceeds the warning limit. By default this value is set to 96. The valid range is from 1 to 127. In USB interface setting warning limit is not supported and it is internally set to 96.
- Message Display: Every Message can be assigned a user defined color and text. The text associated with the message will be displayed in the selected color along with its data in the message display window whenever that message is transmitted or received. By default all the messages received are displayed in black color. Display entries can be configured. This is the number of entries that the display will show. When the messages received exceeds this count Display will scroll to show the latest entries. The display update rate can also be configured. This will be used to refresh the display periodically.
- App Filters: You can opt to view and log messages of your choice. Message filters provide this facility. Filters can be applied to message display window, filters and / or message log. The filter list is configurable from **CAN --> Filter Configuration** menu.
- Message Logging: You can select a file to log all the transmitted & received messages. The start of logging can also be triggered on reception of specific message name or message ID. You can configure a logging session for different time stamping mode as well as Hex/Decimal format. You can also select to append or overwrite an existing log file.
- Message Replay: The messages that are logged to a file can be replayed. The replay can be configured by choosing replay type, time delay and replay file name. You can explicitly specify the delay required between messages or between cycles wherever applicable.
- Transmit Message: You can configure/define messages that are to be sent on CAN bus. The configured messages can be database messages or undefined messages (Undefined messages are those messages that are not available in the database). Further the messages to be sent can be define as standard, extended messages or as a RTR message.
- Simulated Systems: Simulated systems can be configured under CAN Bus consisting of multiple nodes, each representing a dll. Multiple user programs can be built as dlls and loaded. The configured simulated systems can be saved and used across sessions.

The entire above-mentioned configuration except message replay is saved across sessions.

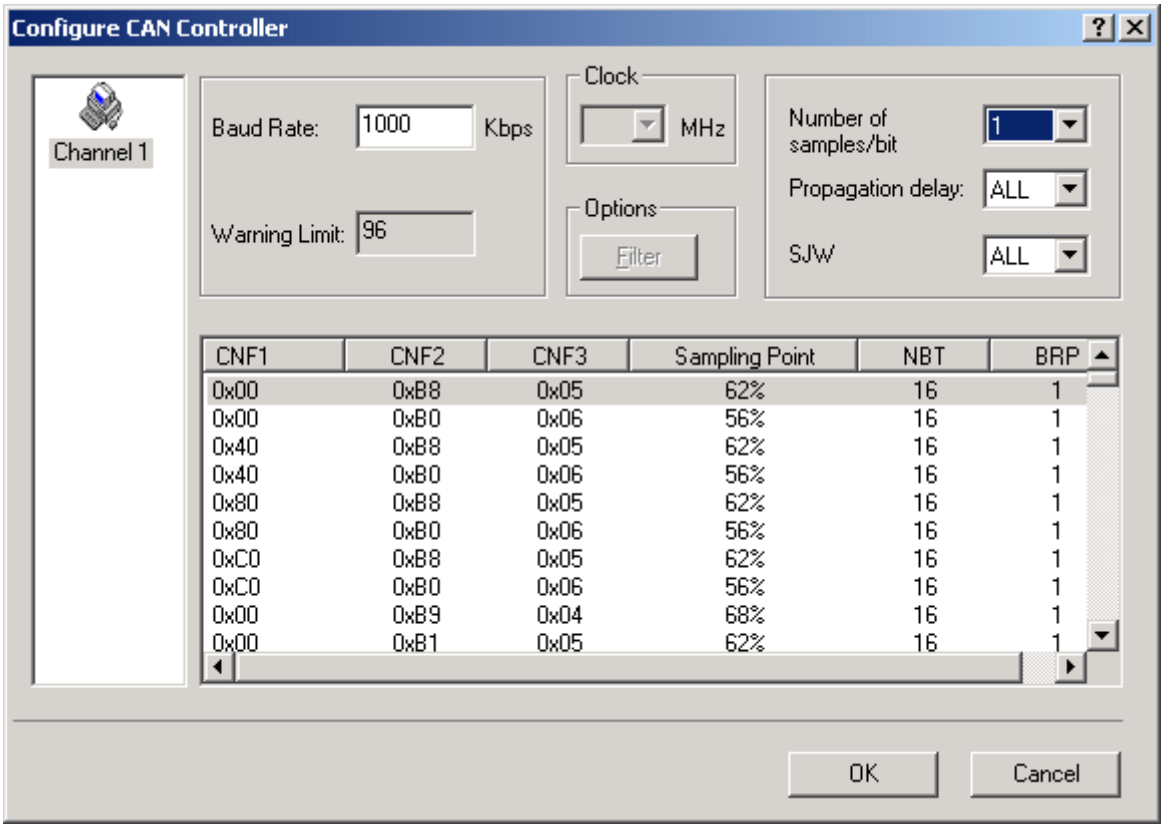
Refer the respective sections for more details

Baudrate

While defining a baud rate the number of samples/bit value can also be defined. For a selected baud rate a set of all possible combinations of CNF0, CNF1 and CNF2 values will be listed. From this you can select any one set. The selected combination of CNF0, CNF1 and CNF2 values will be used to initialize the CAN controller. The baud rate can be changed by the method mentioned below.

- Select **Hardware --> Channel Configuration**.
- Configure CAN Controller dialog box will be displayed as shown below.
- Enter the required Baud rate.
- If required select the Number of Sample/Bit.
- Specific values for propagation delay and SJW can be selected too. Default selection for them is ALL.

- If the default value is not appropriate for the application then the required CNF0, CNF1 and CNF2 value can be selected by selecting an entry from in the list.



Other fields like BRP, Sampling Point, SJW and NBT are dependent on CNF0, CNF1 and CNF2 values. On clicking the "OK" button the controller will be initialized with the selected baud rate.

For more details on bit values of CNF0, CNF1 and CNF2 and the calculation of baud rate refer the section Bit Time Calculation.

Note: For MH Tiny CAN, either Bit Rate or BTR will be considered. If Bit Rate value is available BTR will be discarded.

Bit Timing Calculation

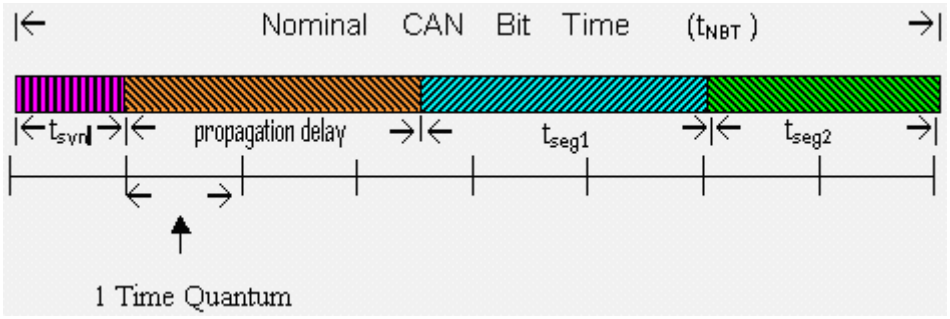
Abbreviations used:

- tNBT - Nominal CAN Bit time
- tsyn - Syncronization segment
- PD - Propagation delay
- tseg1 - Time segment 1
- tseg2 - Time segment 2
- tq - Time quantum
- BRP - Baud rate prescaler
- fsys - Controller system clock
- fclk - Clock Frequency
- NBT - Number of tq in tNBT
- tPD - Propagation Delay time

The CAN protocol supports bit rates in the range of 1Kbps and 1000Kbps. Each node has its own clock generator and oscillator.

Configuring the bit timing parameters for each node can facilitate a common bit rate on the bus.

The Nominal CAN Bit Time (NBT) divided into four segments as shown below.



Hence, tNBT = tsyn + tPD + tseg1 + tseg2

The Nominal Bit Rate is the number of bits per second.

Nominal Bit Rate = 1 / Nominal Bit Time

Each segment consists of a specific programmable number of time quantum, which is basic unit of bit time. The synchronization segment is that part of the bit time where the edges of the CAN bus level.

Mapping between fsys and tq: The controller needs to regulate its system clock period (1 / fsys) in order to realise the time quantum (tq) desired. The coefficient of regulation is defined as Baud Rate Prescaler (BRP). Hence,

tq = 2 * (BRP/ fsys) (I)

fsys = fclk / 2 (II), where fclk is Clock Frequency

tNBT = 1 / baud rate (III)

NBT = tNBT / tq (IV)

Hence from equation (I), (II) and (III)

NBT = (1 / baud rate) / (4 x BRP/ fclk)

=> NBT x BRP = fclk / (4 X Baud Rate)

The product value NBT x BRP will be an integer value. Appropriate baud rate will be calculated to get an integer value for the above product. This will ensure that Clock Frequency remains same for a particular CAN controller.

Additionally,

NBT x tq = tNBT = tsyn + tPD + tseg1 + tseg2 (V)

Clearly,

tsyn = tq (VI)

tseg1 = TSEG1 x tq (VII)

tseg2 = TSEG2 x tq (VIII)

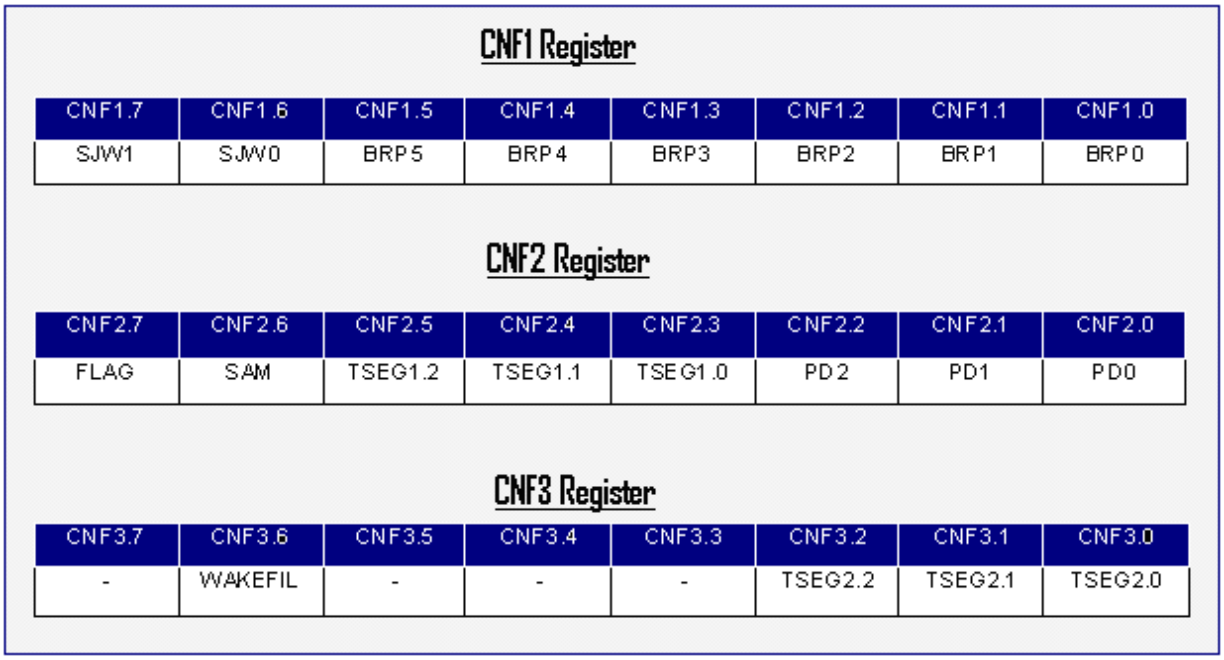
tPD = PD x tq (IX)

Therefore from equation (VI), (VII) and (VIII).

NBT = TSEG1 + TSEG2 + PD + 1.

Sampling Point = ((NBT - TSEG2) / NBT) x 100 %.

The neoVI hardware consist of three registers namely CNF1, CNF2, CNF3 the details of which are given below:



CNF1 Register

CNF1.7	CNF1.6	CNF1.5	CNF1.4	CNF1.3	CNF1.2	CNF1.1	CNF1.0
SJW1	SJW0	BRP5	BRP4	BRP3	BRP2	BRP1	BRP0

CNF2 Register

CNF2.7	CNF2.6	CNF2.5	CNF2.4	CNF2.3	CNF2.2	CNF2.1	CNF2.0
FLAG	SAM	TSEG1.2	TSEG1.1	TSEG1.0	PD2	PD1	PD0

CNF3 Register

CNF3.7	CNF3.6	CNF3.5	CNF3.4	CNF3.3	CNF3.2	CNF3.1	CNF3.0
-	WAKEFIL	-	-	-	TSEG2.2	TSEG2.1	TSEG2.0

SAM (Sampling) = 0 or 1 (1 or 3)

SJW = 2 x SJW1 + SJW0 + 1

BRP = 32 x BRP5 + 16 x BRP4 + 8 x BRP3 + 4 x BRP2 + 2 x BRP1 + BRP0 + 1

TSEG1 = 4 x TSEG1.2 + 2 x TSEG1.1 + TSEG1.0 + 1

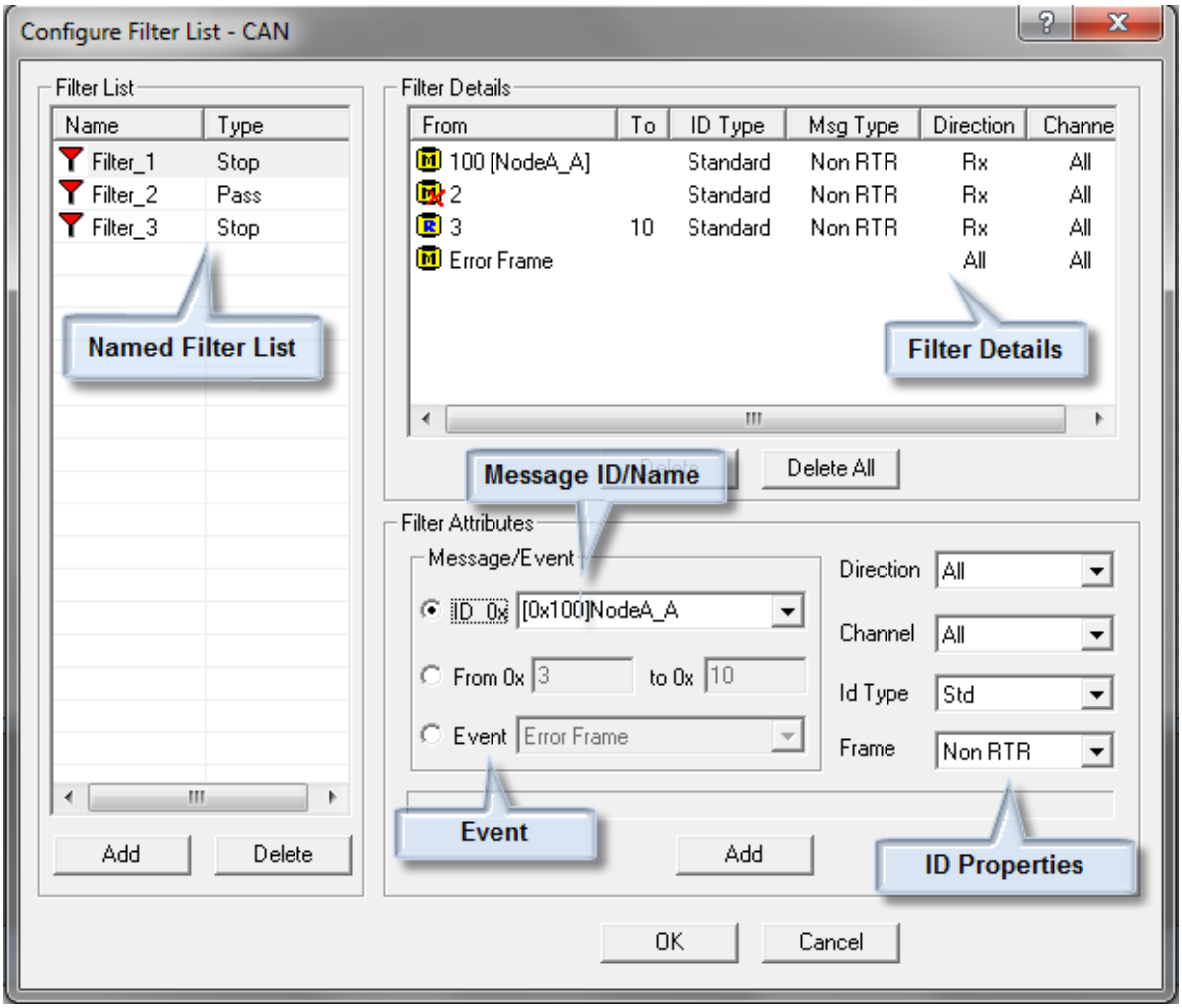
TSEG2 = 4 x TSEG2.2 + 2 x TSEG2.1 + TSEG2.0 + 1

FLAG = 0 or 1 (“TSEG2 Ignored” or “TSEG2 Considered”)

App Filter

User can configure filter list by choosing messages to be filtered.To configure the filter list, follow the steps given below

- Select **CAN --> Filter Configuration**.
- The dialog box specified below will be displayed.



Filter List

It is a list of filters that are identified by the name. The name of the filter should be unique and can have any kind of special characters also. The second parameter tells about the type of the filter, pass or stop. Pass filter allows only the configure message or range of message to pass. On the other size stop filter blocks the configured messages. These filters shall be used in display, logging and replay filters.

Filter Details

This section shows list of message names, ID and range along with ID type, message frame type, direction and channel number. Type is denoted by different icons. Selecting an entry from the list updates the details of the filter in Filter Attributes section.

Filter Attributes

Filter attributes gives more details of selected filter entry. Message Name or ID in case of single id filtering and message ID range in case of range filter will be update. ID type will give whether the ID is standard or extended type. If ID type is "All" then ID type will be ignored. Frame type will show whether the message is of remote transmit request or not. If this field shows all then frame type will be ignored. Direction field will show whether the message is transmitted or received. If it is all then direction will be ignored. Channel filed associates the message with particular channel. Channel all makes the message independent of channels.

Database message names shall be selected from the Message ID combo box. Message ID shall be directly typed in this combo box. If the filter is for a range of messages then the Range radio button shall be selected. This will enable range edit boxes. Message ID type gives information about the ID or message name. For database message this field will be automatically updated. But user can change the type to override the database definition. To make the filter to work for both standard and extended type user shall select the ID type as All. Other attributes shall be selected based on the filter requirements.

Event radio button shall be selected for Event filter. This will enable Event combo box, from which event type can be selected. Channel combo box will enabled.

The Add button in the Filter Attributes section will add configured filter in to the selected named filter list. This button will be disabled in case of invalid parameter entered by the user and appropriate error message will be displayed in the status bar.

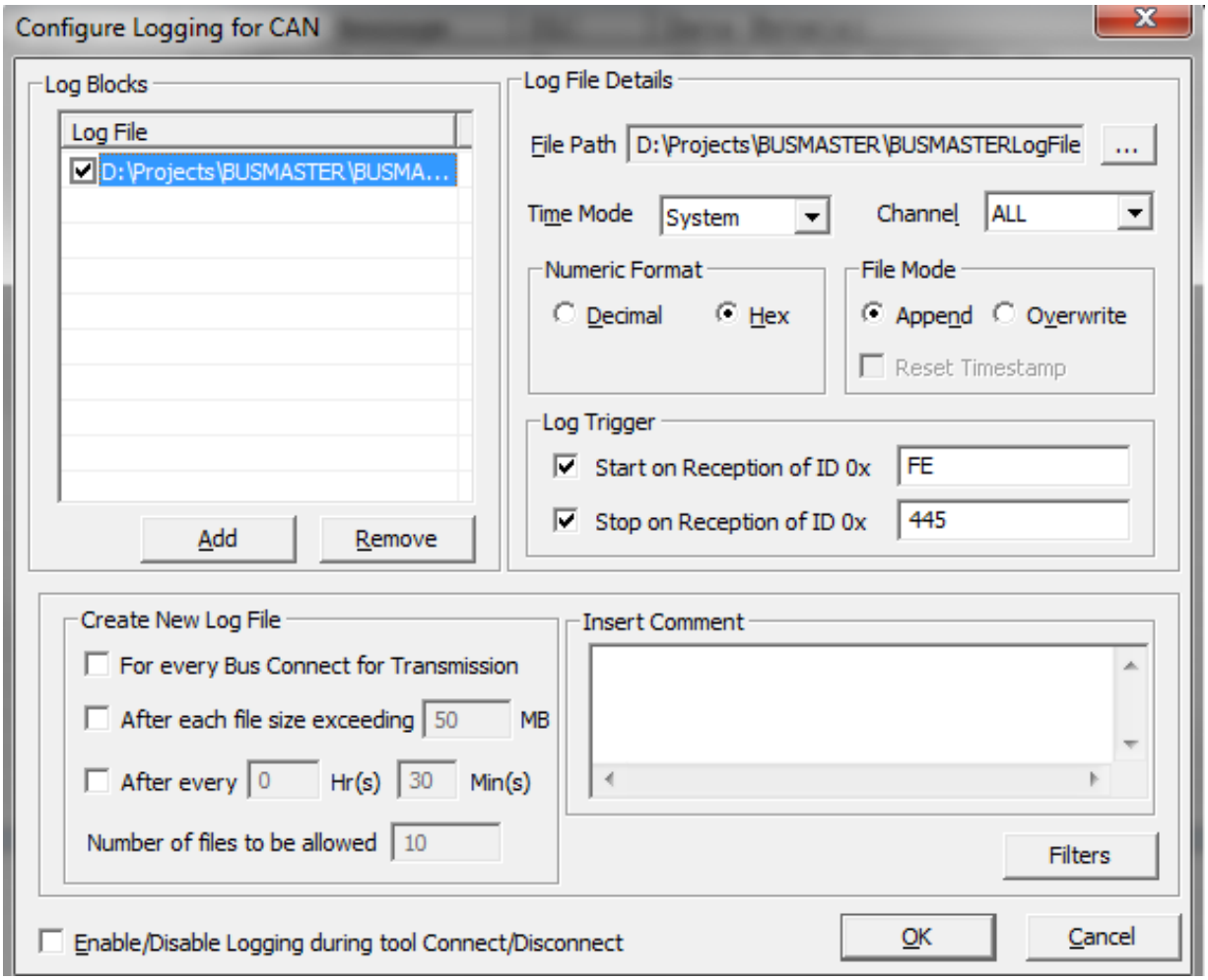
Once the filter is added in to the Filter List then the name of the filter will appear in the Filter Configuration List to select. Any modification on these filter will immediately reflect in the all modules that are using these filters.

Filter list will be saved in configuration file and will be updated while loading a configuration file. While loading a configuration file created with BUSMASTER 3.06.02.X.XXX version one filter entry will be created with the previous filter information.

Log and Replay

Logging

User can configure log file setting using **CAN --> Logging --> Configure** menu. This will show log file configuration dialog as shown below.



Log Files

User can add as many as log files in to the list of Log Files. This list will show the log files that are already configured. To add a new Log file select Add button. This will add a log file with default file name. User can change the file name using "..." button in the Log File Details section. The check box associated with the log file will make the log file eligible for logging. If the check box is not checked logging will not happen to that particular file.

Log File Details

Log file details will give configuration of the selected log file. This will give info of log file path, time mode, numeric mode, file mode, log triggers and log filter.

Log File Path

The file path text box will give the selected log file path. To change the path select "..." button. This will show file selection dialog. On selection of a log file, the file path text box will be updated with selected file path.

Log File Size

Log file size is fixed to a limit of 50 MB. This limit is set as most of the editors will take lot of time to open if the file size is large.

Time Mode

Logging of messages can be done in three different time modes. System time, Absolute time and Relative time mode. In system time mode time stamping of message is done using real time clock of the system. In absolute time mode the time stamping is done with respect the to the absolute timer that will be stated during connect. In relative time mode the time stamping of a message is with respect to previously received message.

Reset Timestamp for every enable logging is provided. If this option is selected then the absolute time will be reset whenever the logging is enabled.

Numeric Mode

This tells the numeric format of log file entries. It has two options Hex and Decimal. Message ID and data bytes of a CAN message will use this as a base while format for logging.

File Mode

In Append file mode, log sessions will be appended at the end of the file. Each logging session will have its own session header and footer. In Overwrite file mode the file will be overwritten for the first session. For consecutive sessions the file name will be suffixed with an incrementing number and each session will be logged in new files. The log file name will be incremented every-time when you stop the logging process.

If already log files are created in the previous session and if a new session is started, then the log files created already will be overwritten in both overwrite and append mode. In this case, the successive files already created in the previous session will contain old session data.

Logging Indication

Recording or logging is indicated in the status bar for both CAN and J1939. When the logging is enabled and data is logged in to the file, an icon will be shown in the status bar with glowing on and glowing off continuously till the logging is stopped. When the logging is stopped then icon will be disabled.

Example

If the log file name is xyz.log for the first time, then for the next time the log file name will be xyz0.log.

Similarly, if the log file name is xyzn.log for the first time, where n – is any number, then for the next time the log file name will be xyzm.log, where m = n + 1.

Create New Log File

Measurement - New Log file can be created for every Bus Connect. The new log file will have a file name. Eg: BusmasterLogFile_CAN_Mn.log where 'n' is the count, and 'M' indicates logging is 'Measurement' based.

Size - New Log file can be created with log file exceeding certain file size. The new log file will have a file name. Eg: BusmasterLogFile_CAN_Sn.log where 'n' is the count, and 'S' indicates logging is 'Size' based.

Time - New Log file can be created for certain interval of time. The new log file will have a file name. Eg: BusmasterLogFile_CAN_Tn.log where 'n' is the count, and 'T' indicates logging is 'Time' based.

Comment

Comments can be inserted to the header of the log file.

Filters

Filters can be added for logging.

Enable/Disable Logging on Tool Connect/Disconnect

Logging can be enabled/Disable on Connect/Disconnect to CAN bus.

Message Log

CAN messages can be logged to a file for analysis. Log file name shall be selected as described in section Logging.

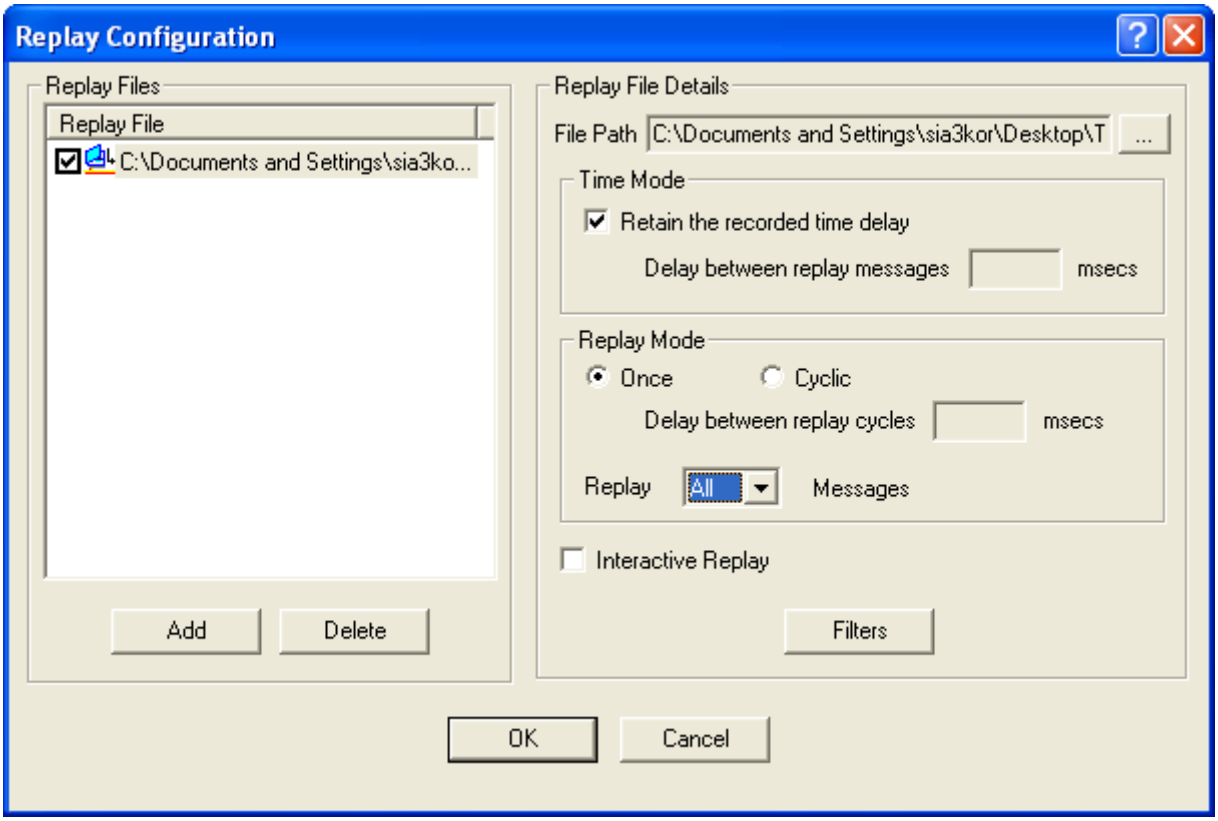
To start message logging select Log Start or press the Tool Bar Button shown in the figure below. The tool bar is toggle button. Clicking on the button or selecting the menu again will stop logging. Once the logging has started, the messages received and transmitted will be logged in to the file with time of message reception.

Note:

- Logging will fail if the log file is not present in the specified location.
- Logging status is stored in configuration file and logging will be started automatically during application startup if it is enabled and saved in the configuration file.

Replay

User can configure replay file setting using **CAN --> Replay --> Configure** menu. This will show replay file configuration dialog as shown below.



Replay Files

User can add as many as replay files in to the replay list. This list will show the replay files that are already configured. To add a new Replay file select Add button. This will show replay file selection dialog. User can select log files that are created using BUSMASTER. Once the user has selected a replay file, the file will be added to the replay list. User can change the file "... " button in the Replay File Details section. The check box associated with replay file will make the replay file eligible to run. If the check box is not checked then that replay will not be used for replay.

Replay File Details

Replay file details will give configuration of the selected replay file. This will give info of replay file path, time mode, replay mode, filters and Replay type.

Replay File Path

The file path text box will give the selected replay file path. To change the path select "..." button. This will show file selection dialog. On selection of a log file, the file path text box will be updated with selected file path.

Replay Time Mode

Time mode or replay tells whether to use logged time for replay or to use user specified value. If user selects Retain Delay option then the delay between messages will be calculated from the log file time stamping. If this option is not checked then user can specify the delay between messages.

Replay Mode

Replay mode instructs whether the replay file has to be transmitted only once or cyclically. In cyclic mode, messages will be transmitted periodically. User can specify the cycle delay which will be used in between cycles. Where as in monoshot or once, the replay of messages will happen only once.

Replay messages option is provided to select the messages to tbe replayed. Tx, Rx and All messages options are listed. All the messages in the log file will be replayed if All is selected. If Tx is selected then only the messages logged with Tx flag in the log file will be replayed. If Rx is selected then only the messages logged with Rx flag in the log file will be replayed.

Interactive Replay

In interactive replay mode, the log file content will be display as list of messages and user can navigate this list and can transmit interested messages. User can step through replay messages, can skip messages, can start message transmission continuously and can insert break points.

Non Interactive Replay

In non interactive mode, reply will start during tool connect and will be stopped during tool disconnect. In case of cyclic mode the replay will continue till tool disconnect and in monoshot or once, all messages will be transmitted only once and replay will start.

Configure Replay

Replay can be configured using the three parameters mentioned below

- File Name
- Mode
- Time Delay

There are two modes of Replay

- Single Run - The messages in the file will be replayed only once.
- Cyclic - The messages in the file will be replayed cyclically.

The time delay can be set to control the delay between two consecutive messages and between two consecutive replay of the same file.

The following field controls delays

- Recorded time delay in the log file
- Time delay between messages.
- Time delay between cycles – Applicable for only cyclic mode.

Time delay 1 and 2 are mutually exclusive irrespective of replay mode. This time delay is the time duration between transmission of two consecutive messages. The minimum time delay (in milliseconds) is one millisecond.

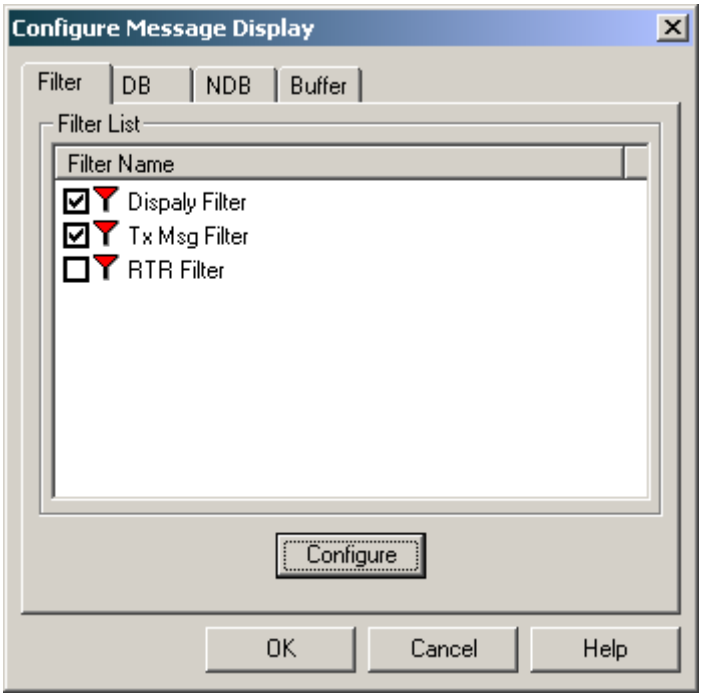
On clicking the OK button a Message Replay Window will be displayed. This will contain all messages in the replay file. By default first message in the replay window will be selected. Please see section Replay a File for further details.

User can configure to replay all message logged or only transmitted message or only received message by selecting the option from Replay Message Type. It can be done during configuration of replay.

Message Display

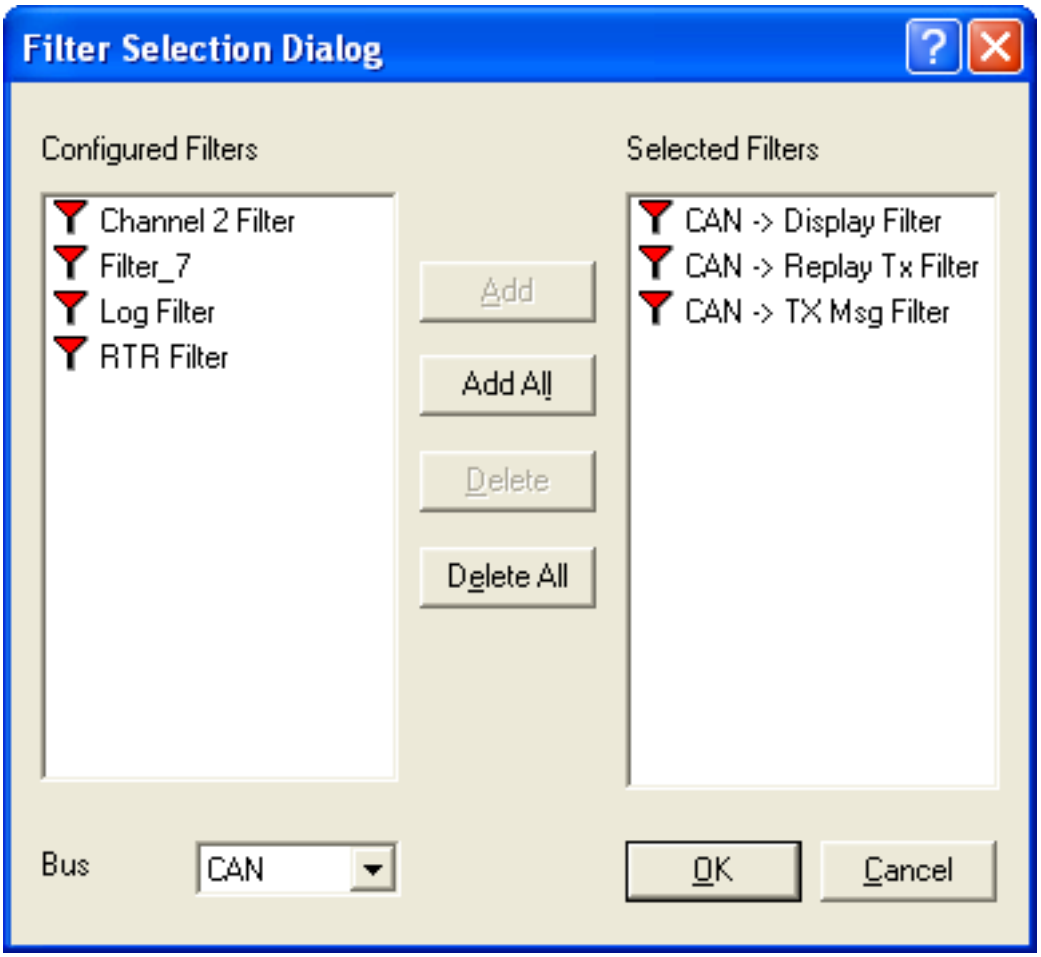
Message Filter

Filters for message display can be configured by selecting **CAN --> Message Window --> Configure** and by selecting Filter tab. This will show list of filters configured for Message Display.



Display Filter

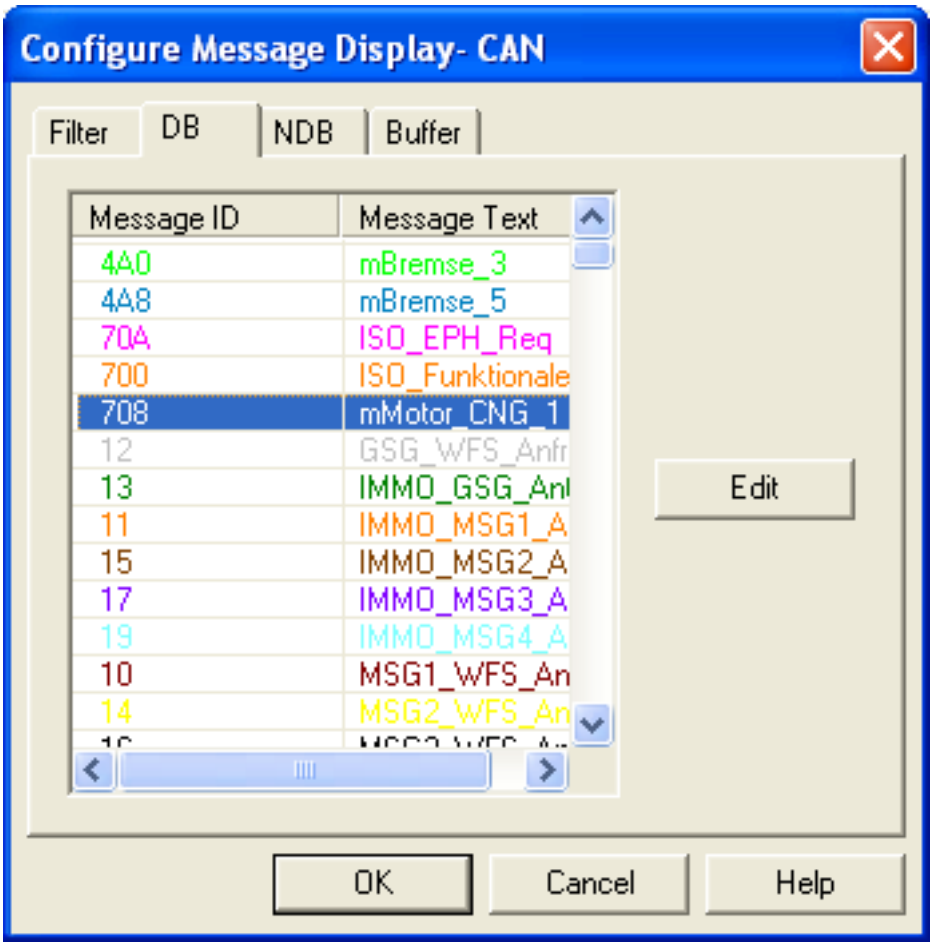
To configure display filter list select Configure button which will list available filters and selected filters.

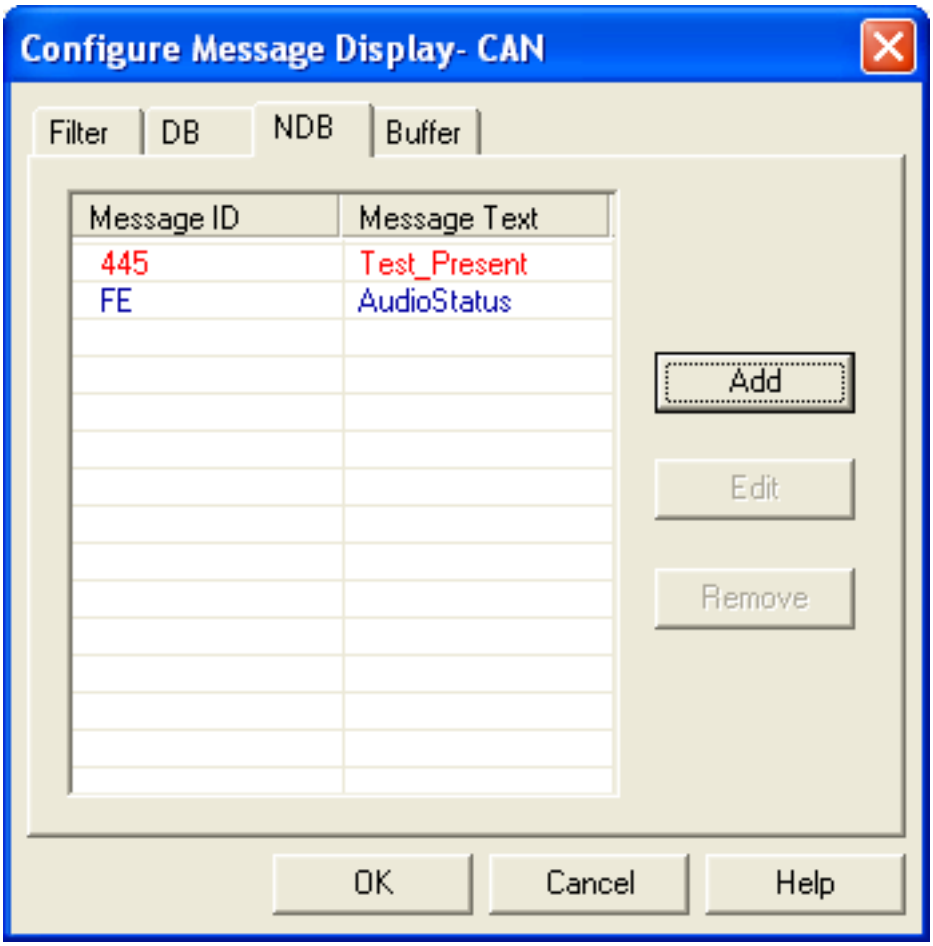


Message Coloring

User can configure the color with which the message will be displayed and associate a textual description to message.

By default all messages are displayed in black color and the message ID itself as the associated text. For the database message user can only edit the color.

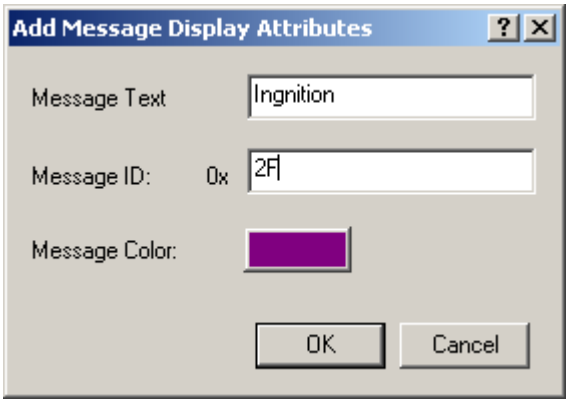

Configure Message Display- CAN
Filter
DB
NDB
Buffer
Message ID
Message Text
4A0
mBremse_3
4A8
mBremse_5
70A
ISO_EPH_Req
700
ISO_Funktionale
708
mMotor_CNG_1
12
GSG_WFS_Anfr
13
IMMO_GSG_Anl
11
IMMO_MSG1_A
15
IMMO_MSG2_A
17
IMMO_MSG3_A
19
IMMO_MSG4_A
10
MSG1_WFS_An
14
MSG2_WFS_An
Edit
OK
Cancel
Help



Adding message attribute

To configure a message display option, please follow the steps given below

1. Select **CAN --> Message Window --> Configure**
2. Dialog box Configure Message Display as in above figure will be displayed
3. Click on Add button
4. One more dialog box Add Message Display Attributes as shown below will pop up.



5. Enter the message ID and Message text
6. Click on the colored button to select a color, This click pops up a color palette as shown above.
7. Select a suitable color
8. Select OK button to confirm

Subsequent reception / transmission of the message that has been configured will be displayed with associated text & color.

Editing a message attribute

To edit the message attributes please follow the steps given below

1. Select **CAN --> Message Window --> Configure**.
2. Dialog box Configure Message Display will be displayed.
3. Select the message entry to be edited from the message list.
4. Either click on Edit button or double click on the selected entry.
5. One more dialog box Edit Message Attributes will pop up.
6. Change the required Message attributes.
7. Select OK buttons to confirm.

Subsequent reception/transmission of the message that has been configured will be displayed with associated text & color.

Deleting message display attribute

To delete an entry from the Message List follow the steps given below

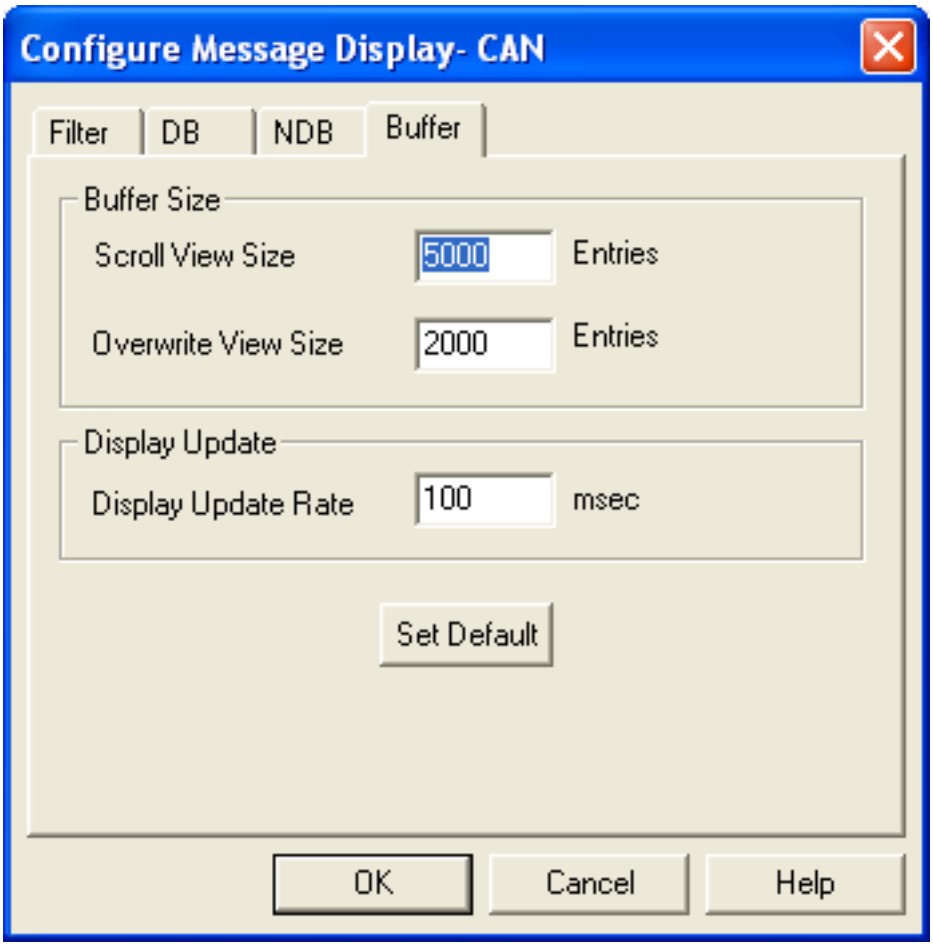
1. Select **CAN --> Message Window --> Configure**.
2. A dialog box will pop up. Select the message entry to be deleted from the message entry list.
3. Click on Remove button. A delete confirmation message box will be displayed.
4. Select Yes to confirm deletion.
5. Select OK button to confirm the modification of entries.

On subsequent reception/transmission, the message will be displayed in black color.

Display Buffer size & Update Rate configuration

To configure Append and overwrite buffer size, follow the steps given below

1. Select **CAN --> Message Window --> Configure**.
2. A dialog box will pop up. Select the Buffer page.



3. The buffer size can be from 200 to 32500 display entries. The display update rate can be from 50 to 20000 milliseconds.
4. Set entries for Append buffer and overwrite buffer. Set display update rate.
5. Select OK button to confirm the modification of entries.
6. Select Set Default button to set the default values.

Show Last Option

This option can be used to set the focus of the list item to the latest item in Scroll mode. In append mode latest message entries will be added at the end. To make the latest entries visible always select **CAN --> Message Window --> Show Last**.

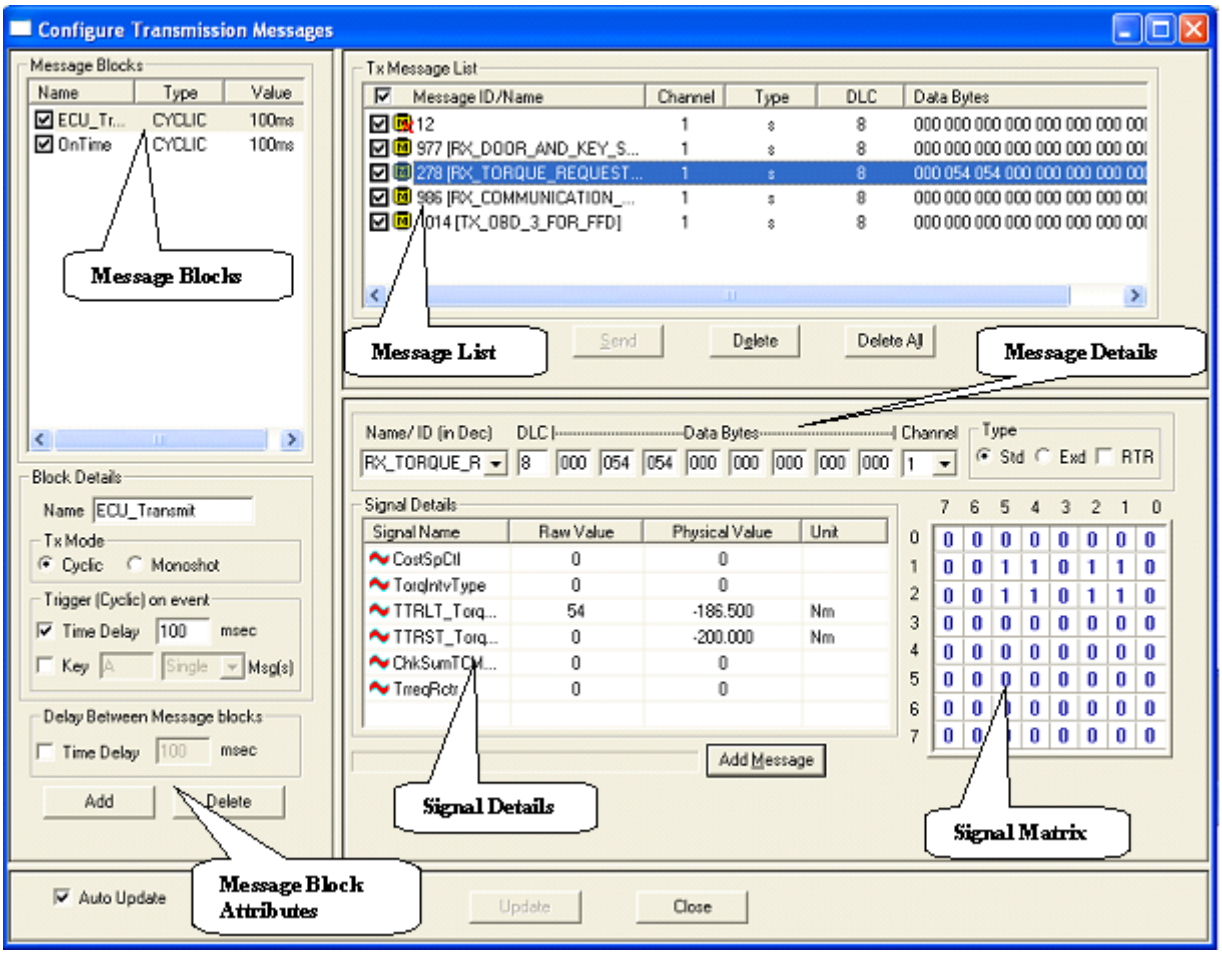
Note:

- In overwrite mode this option will be disabled to avoid rolling of selection.
- Selection will be update only during display update.

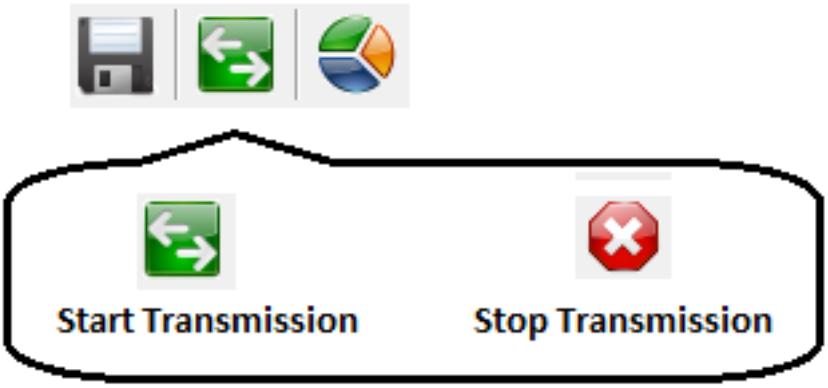
Transmit Messages

Messages can be send over CAN-bus by following the steps given below. Select **CAN --> Transmit --> Configure** menu option. This will display the dialog as shown is figure below.

Getting Started



- Add a message block and select the trigger as “On Key” or “On Time” or both. Select a name of message block and then enter appropriate message details in “Configure Message“.
- If the field for Message ID/Name has a database message then DLC and frame type will be updated with database information. The Signal List will be enabled with signals defined in the database. Signal Raw or Physical values can be directly entered in this list. After validation the data will be updated.
- Signal descriptor can be used to enter physical value. Double clicking the physical value cell of a signal that got descriptor will show a list of signal descriptors.
- If the message ID is not a database message enter DLC, Message bytes. In this case signal list will be disabled.
- RTR message can be added to by selecting RTR checkbox
- If there is selection in the message list, changes will update the selected message.
- Selecting Add Message button will add a new message entry.
- Database messages can be directly entered by name or ID in the Message ID/ Name combo box or can be selected from the combo box list items.
- Signal Matrix will show the bit pattern of the data bytes.
- Instead of using Update button, Auto Update option can be selected to dynamically save the data.
- Select Update button to save the changes and press the toolbar button shown in the figure below.
-



Note:

- Start/Stop Transmission toolbar button will be enabled only if the tool is connected.
- Message transmission shall be stopped with out tool disconnect.

The messages added in to the Tx message list can also be modified. Follow the steps given below.

- Select an entry in the message list. The selected detail will be unpacked and will be displayed in the edit controls below. If it is a database message then the signal details will be listed in the signal list with both physical and raw values.
- Any modification in Message Name/ID, DLC, Data bytes, signal raw and physical values will directly reflect in the selected message entry in the message list. The signal matrix will also get updated to reflect the changes.
- Selecting Apply or OK button will reflect message details change in transmission immediately if message transmission is on.

User can delete a message frame entry from the list by following the steps given below.

- Select **CAN --> Transmit --> Configure** menu option. This will display the dialog box as shown below in figure (a).
- Select an entry in the message frame list.
- Select Delete button. A delete confirmation will be displayed. Select Yes to confirm deletion. The selected item will be deleted from the list. Multiple items can be selected to delete multiple items in one shot.
- Select Delete All button to delete all entries in the message block. A delete all confirmation will be displayed. Select Yes to confirm deletion. This will clear message block entries.
- The other way of doing delete is Right click mouse button. This will display a pop-up menu Delete and Delete All. Select Delete pop-up menu. A delete confirmation will be displayed. Select Yes to confirm deletion. The selected message frame will be removed from the message frame list.

The added messages can be directly transmitted instantaneously. The steps to do this is listed below

- Select a message entry or message entries from the message list.
- Select Send button to transmit these messages.
- The other way of doing this is right click on selected message entries. This will show a popup menu with Send option. Select Send to transmit selected messages once.

Note:

- To send a message tool should be in connected state.
- If more then one message are selected to send, all messages will be transmitted one after another without any delay.

Transmission Blocks - In Detail

The transmission blocks are segregated in to Message Blocks and Message frames that belong to a block. Message blocks will have logical name and triggering attributes and list of messages. Message block name is logical representation of the block. Message block attributes are triggering type and trigger value.

Triggering Type

Two types of triggering are supported by BUSMASTER. These are timer and key triggering. In timer triggering messages will be transferred periodically with the time delay mentioned in the trigger value. In case of key triggering the message will be transmitted on press of the trigger character. These options will go along with the repetition mode called Monoshot or Cyclic. In monoshot mode messages belong to a block will be transmitted only once. After completing the cycle of transmission nothing will be transmitted. In cyclic mode message transmission will happen cyclically. After completing one cycle of transmission, first message in the block will be transmitted and so on.

In case of key triggering, if the mode is monoshot, messages in the block will be transmitted one after another for each trigger key press. Once all messages are transmitted nothing will be transmitted. If the mode is cyclic after completing one cycle the first message will be transmitted on press on the key again and this cycle will continue. The special attribute All Message is used to generate heavy load condition. This is attribute is applicable only for key triggering. If All Message is checked and the mode is monoshot, on press of the key all messages will be transmitted once without any delay in between. If the mode is cyclic then all messages will be transmitted continuously with out any delay in between. This can be stopped only be stopping the Tx message transmission.

Triggering Value

For timer triggering the triggering value is in milliseconds. The minimum supported timer value is 1 millisecond. For key triggering the value can be A-Z, a-z, 0-9.

Note:

- Key trigger character is case sensitive.
- Same key character shall be used for multiple message blocks.
- One block shall be configured as both key and time triggering.

Time Delay Between blocks

Time delay between blocks is used to transmit one block of data at a time. This supersedes time delay between messages. When "Time Delay" for Delay Between Message Blocks is checked the "Time Delay" for Trigger will be disabled and the time will not be considered for message transmission. When the "Transmit Messages" is selected, the messages in the block will be sent immediately. After the given time delay between blocks is elapsed, messages of the second block will be sent and will be continued till all the blocks are sent.

When the "Time Delay" for Delay Between Blocks is unchecked the "Time Delay" for Trigger will be enabled and the previous check status will be maintained.

If the Tx Mode selected is monoshot then the messages will be transmitted only once. For cyclic mode, messages will be transmitted continuously based on the delay given.

If key trigger is selected as Trigger event then messages will be sent on the key press event

Adding a Message Block

To create a new message block select Add from Message Blocks frame. This will create a new message block with default values and with empty message list. User shall modify attributes of the message block to customize the message block. User shall be able to add maximum of 32 message blocks.

Deleting a message Block

To delete a message block select the message block from the list and select Delete button. This will prompt delete confirmation dialog. Selecting Ok to this dialog will delete message block from message blocks list. Deleting a message block will remove all messages belong to that message block.

Addition and Deletion of message block shall be done by using context sensitive popup menus. This will be displayed if the user right clicks on message block list.

Message List

Message list will show the list of messages belong to a message block. A message block shall be selected from Message Block to see the list of messages it has. Message list will show message frame with its ID, Name if it is a database message, frame type, DLC and data bytes. The icon used for each entry will denote whether it is a database message or non database message. The data bytes will be listed in hex or decimal format as per the tool

bar numeric mode. By default massages will be displayed in hexadecimal mode.The frame type will show the message is using standard frame type or extended frame type. The RTR messages will be denoted by 'r'. With message in the list the following operations shall be performed.

Send

This will send the selected message(s) immediately. To perform this action the tool must be in connected state. The selected messages will be transmitted on CAN bus with out having any delay in between the messages.

Delete

This will delete the selected message entry from the message block. Multiple selections shall be done to delete more then one messages. A delete confirmation message will be popped up before deletion. On selection of Yes to this confirmation the selected messages will be deleted.

Delete All

This is to clear the message list. This will show a confirmation message. Selecting Yes to this confirmation will clear all messages in the message block.

Configuring Message Details

A message details shall be configured in different ways. Message details like ID/Name shall be directly typed in the Message Name/ID combo box. Database message names shall be either directly typed or selected from the drop down list. This list will be populated with the imported database messages. Similarly message ID shall be directed entered here. If corresponding database message found, this will be replaced with the message name.

Message length shall be entered or modified using the field DLC. The allowed DLC vales are 1-8. If a database message is entered or selected from the drop down list, the length of that message will be automatically taken from the database and will be filled in this field.

Data bytes values shall be directly entered using Data Bytes fields. The message data shall be meaningfully entered using signal values of the message. Only for a database message signal values shall be given. For non database messages the value can be entered only through data bytes fields.

Message Type can be configured using Standard/Extended radio button and RTR check box. Message will be validated on change of frame type.

Any message can be converted to RTR by checking the checkbox RTR. Signal details of a message will be removed if the message is of type RTR.

Signal Details

For a database message, all signals belonging to the message will be displayed in the signal list with its physical value with unit and raw value. User shall enter value in terms of physical value of the signal or raw value of the signal. If signal descriptor is defined for a signal then physical value will show list of signal descriptors while entering the signal value. This makes entering value of a signal. Message data bytes, physical and raw values will be updated if there is any modification in these fields. Any modification in physical value of a signal will be updated appropriately the raw value and data bytes packing and same for raw value and data bytes modification.

Note:

- Changing data bytes may violate signal boundary validation. If the data bytes of a database message are modified directly, the message will be made as dirty. This will be denoted by a * in message list.

Signal Matrix

Signal matrix will show the packing of the signal values in to the data bytes visually. This matrix has 64 cells and each represents one bit of the message data byte. If message length is lesser then 8 bytes then the invalid bytes will be disabled. While selecting a signal from the signal list, it will be highlighted in the signal matrix. This matrix will be handy to visualize the signal packing in to the data bytes. For a RTR message this matrix will be disabled.

Signal Definition

To get the definition of a signal just double click the signal name from the signal list. This will pop up the signal definition dialog from data base. The signal Type, Length, Start Bit, Minimum and Maximum value, Offset, Factor and unit information will be displayed.

Add Message

This button will create new message entry in the selected message block. This will take the valued of message details field and will create a new message frame. This message will be put in to the message list of selected message block.

Status

A status text will be update for any invalid data entry. This will be cleared of the invalid data got modified to a valid one. This will show appropriate error messages for an invalid data entry. Once valid data got this text will be cleared and consequently the Add Message button will be enabled.

Note:

- If a message is selected from the message list then all modifications will update the selected message.
- If none of the message is selected then modifications are local and only Add Message will add this data in to the message list as a new message.
- A new message shall be added any time by selecting the Add Message button. This button will be enabled only if the data entered in message details field are valid.
- Maximum of 64 messages shall be added in to a signal message block. Maximum of 32 Message Blocks shall be added.

Apply

To make changes to reflect the transmission, select Apply button. This will make changes permanent and the changes will reflect in the transmission if TX is on. The TX dialog will remain open to continue modifications.

Ok

This will make changes permanent and will close the dialog. The changes will reflect in the transmission if TX is on.

Cancel

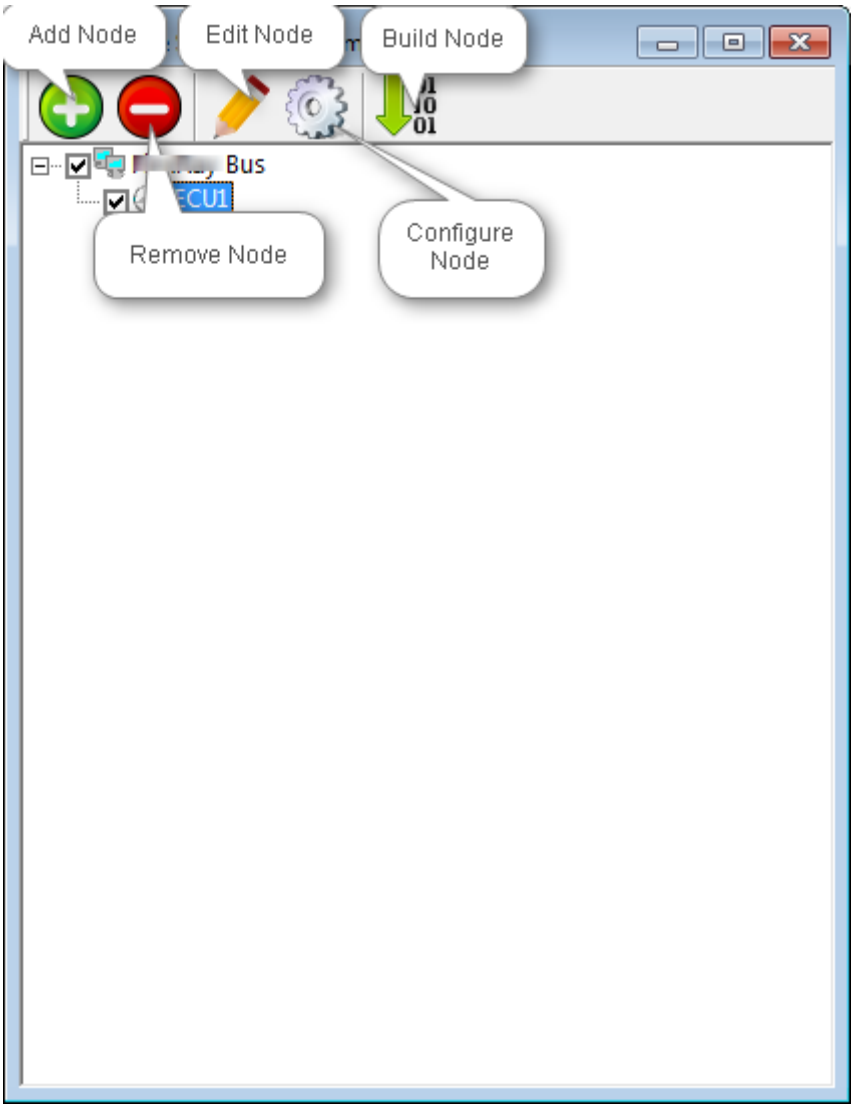
To cancel the changes select Cancel. This will close the dialog with out saving the changes. All changes will be ignored and can not be recalled.

Note:

- Signal Value shall be modified even if the transmission is on.
- New Messages shall be added in to the message block even if the transmission is on.
- If Message Transmission is on message from any block can not be deleted Any active message block (with check box is on in Message Block list) can not be switched off if Tx is on.

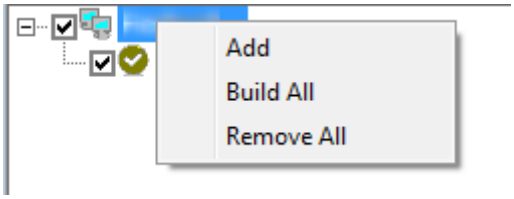
Node Simulation Configuration

Simulated systems can be configured under the <Protocol>-bus by following the steps given below. Select <**Protocol**> --> **Node Simulation** --> **Configure** menu option. This will display the window as shown is figure below.



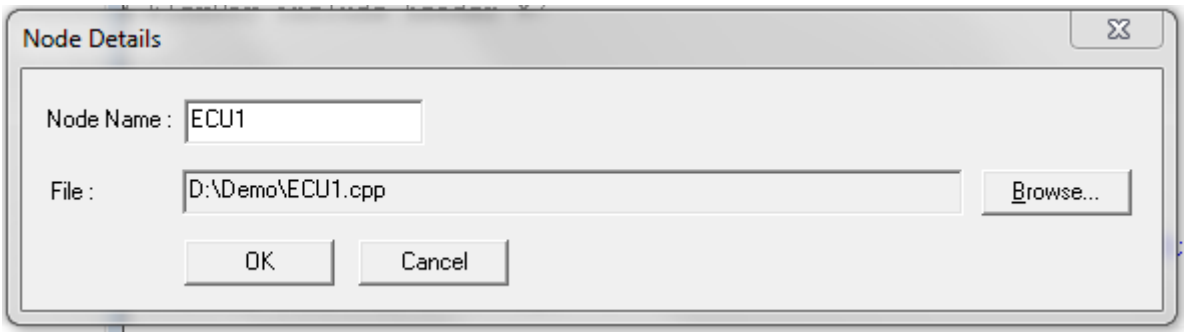
Add Node

This is used to added .cpp/.dll files to Node Simulation. Add Node can be done by following ways:



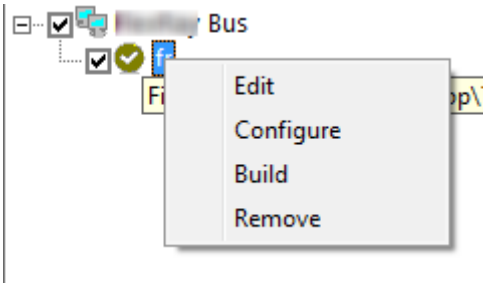
1. Right click the Root Node(<Protocol> Bus) and select "Add".
2. Click Add Node in the toolbar.
3. Pressing "Insert" key in the keyboard.

Then "Node Details" dialog box appears as shown below. Add unique Node name and add existing .cpp/.dll or provide new File name to create new .cpp file.



Edit Node

This is used to edit the .cpp file attached to a Node. Editing can be done by following ways:



1. Select the Node then Right click and select "Edit".
2. Select the Node and click "Edit Node" in the toolbar.
3. Select the Node and press "Enter" key in the keyboard.

Then "Function Editor" window appears in which the required editing can be done.

Remove Node

This is used remove selected node all the nodes in the Simulated system. Removing a Node can be done by following ways:

1. Select the Node then Right click and select "Remove". To Remove All Nodes select Root Node(<Protocol> Bus) and select "Remove All".
2. Select the Node and click "Remove Node" in the toolbar. To Remove All Nodes select Root Node(<Protocol> Bus) and select "Remove Node" in the toolbar.
3. Select the Node and press "Delete" key in the keyboard. To Remove All Nodes select Root Node(<Protocol> Bus) and press "Delete" key.

Configure Node

This is used change the name of the Node or change/add .cpp/.dll associated with a Node. Configuring a Node can be done by following ways:

1. Select the Node then Right click and select "Configure".
2. Select the Node and click "Configure Node" in the toolbar.
3. If no .cpp/.dll files are associated with the node previously, then by pressing "Enter" key in the keyboard.

Build Node

This is used build the .cpp files associated with selected Node or all the nodes in the Simulated System. Building a Node can be done by following ways:

1. Select the Node then Right click and select "Build". To Build All Nodes select Root Node(<Protocol> Bus) and select "Build All".
2. Select the Node and click "Build Node" in the toolbar. To Build All Nodes select Root Node(<Protocol> Bus) and select "Build All" in the toolbar.

Enable/Disable Node

This used to active/deactivate selected Node or all the Nodes in the Simulated System. Enabling/Disabling can be done by following ways:

1. Check/Uncheck the checkbox associated with the Node will Enable/Disable the Node respectively. To Enable/ Disable all the Nodes Check/Uncheck the Root Node(<Protocol> Bus) respectively.
2. "Spacebar" key can be used as keyboard shortcut to Check/Uncheck the Node(s).

Note:

1. Node(s) can't be Added/Removed/Configured/Enabled/Disabled while the network is connected.
2. A Node can be edited while the network is connected. But the file must be built again to see the changes.

Function Editor

BUSMASTER can work as a programmable node over a CAN bus. User can program different event handlers using function editor. The programming language is C.

Five types of event handlers are supported.

- Message Handlers
- Timer Handlers
- Key Handlers
- Error Handlers
- DLL Handlers

These function handlers when built and loaded are executed on

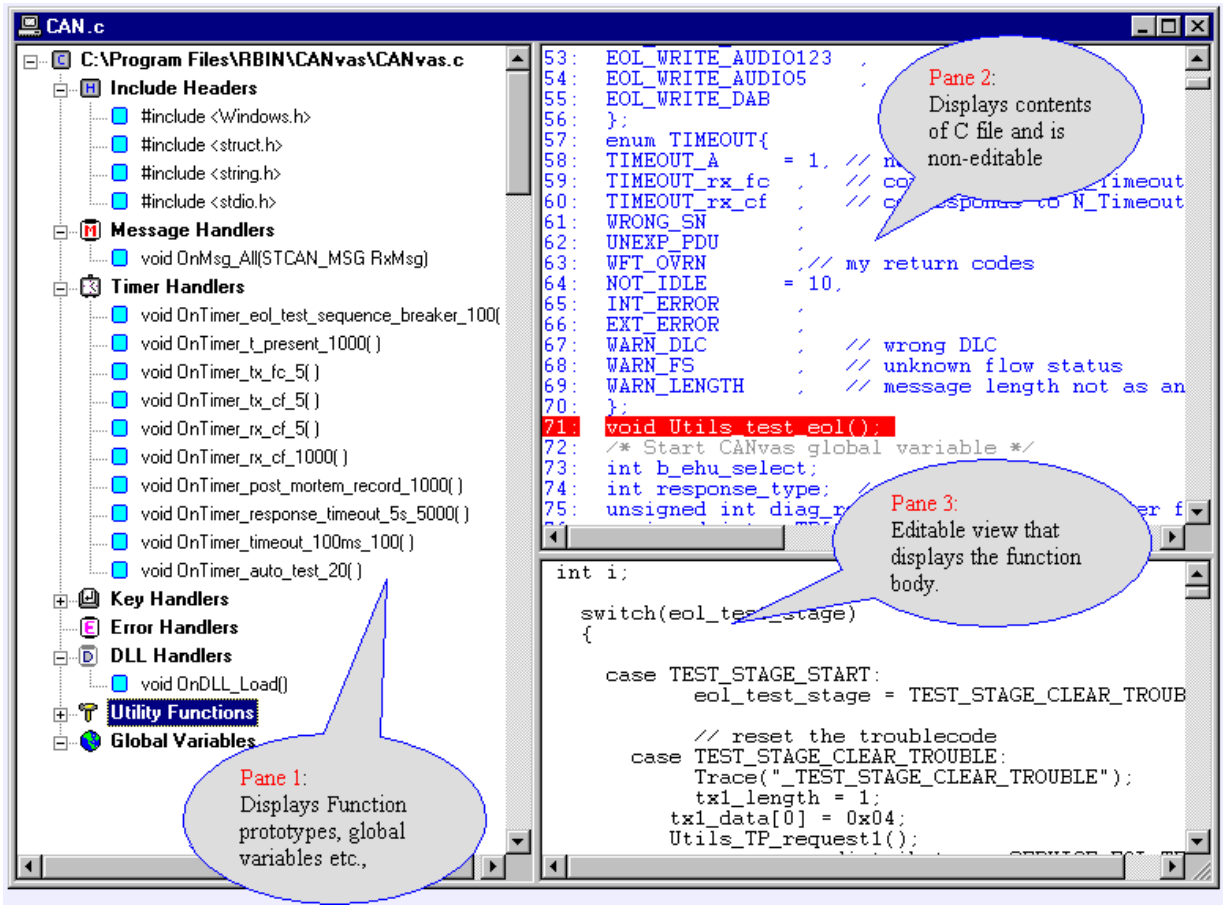
- Receipt of a Message.
- Elapse of a time interval.
- Press of a Key
- Detection of error or change in error state
- Loading / unloading of DLL.

User can also include Header File names, add Global Variables and Utility Functions while programming the event handlers. All these functions can be edited and saved in a file with extension ".c". The source file can be built to a DLL. This DLL can be loaded dynamically.

There are three panes in function editor as shown below

- Left Pane : Will be called Pane 1.
- Right Top Pane : Will be called Pane 2.
- Right Bottom Pane : Will be called Pane 3.

Pane 1 displays the list of functions, included header files and global variables defined. Pane 2 displays the contents of the source file. Through Pane 3 User can edit the body of function selected.



General access to the function editor

Go to **CAN --> Node Simulation --> Configure** to open the window **Configure Simulated Systems**. Right click on **CAN Bus** in the left pane and select **New Simulated System** or **Add Simulated System** . Select then the "sim" file.

Right click on the new simulated system and select **Add Node** . The name will also be used as basename for the generated DLL. The **Node Details** will become visible in the right pane.

Create a new function

Follow the description in the previous chapter "General access to the function editor".

Select **Add New File...** in the right pane under **File Details** to add new functions to the node. The function editor will open automatically.

Edit an existing function

Follow the description in the previous chapter "General access to the function editor".

Select **Edit File...** in the right pane under **File Details** to edit an existing function of the node.

Include Header file

User can include a header filename while programming event handlers. To do so please follow the steps given below:

1. Select **Include Headers** category in the Pane 1 and right click.
2. A pop-up menu comes up. Select **Add**. A dialog box appears.
3. Click on **Browse** button to select the required header file name and click on **OK** button.
4. The selected header filename will be added to the source file in the Pane 2 and also under **Include Headers** category in Pane 1.

Edit Include Header File Name

User can edit the name of the header file, to do so please follow the steps given below

1. Select the **Include Header** filename under **Include Header** category to be edited in the Pane 1 and Right click.
2. A pop-up menu will be displayed.
3. Select **Edit**.
4. A dialog box will be displayed.
5. Click on **Browse** button to select the required header file and click on **OK** button.

The selected header file will be replaced with the previous header file in the source file in the Pane 2 and also under **Include Headers** category in Pane 1.

Delete Handlers

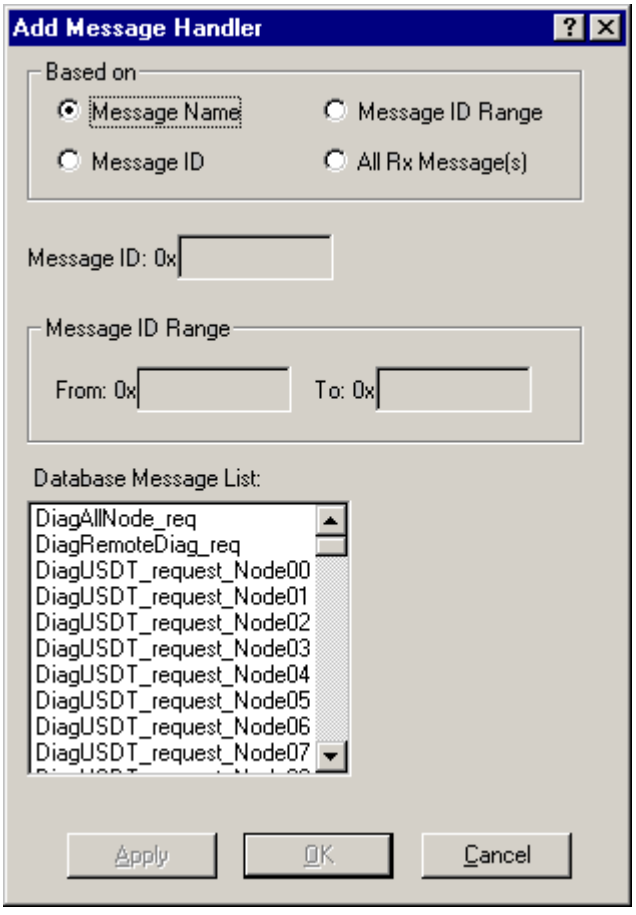
User can delete Header files, Message Handlers. Timer Handlers, Key Handlers, Error handlers, DLL handlers and Utility Functions in source file opened for editing, to do so follow the steps given below:

1. Select the item to be deleted in the Pane 1 and right click.
2. A pop-up menu will be displayed.
3. Select **Delete**.
4. A confirmation message is displayed.
5. Select **Yes**.

The selected item's definition will be deleted from the source file in the Pane 2 and also in Pane 1.

Add Message Handler

1. Select **Message Handlers** category in the Pane 1 and right click.
2. A pop-up menu will be displayed.
3. On selecting **Add** menu. A dialog as shown below pops up.



4. From this dialog message handlers of different type can be selected. The different types of message handlers supported are
   - Message handler based on the message name.
   - Message handler based on message ID.
   - Message handler based on range of message ID.
   - Message handler for all received messages.

The type of message handler can be selected using the radio buttons. To add handler based on the message name the corresponding message should be available in the imported database. Multiple messages can be added from this dialog box by clicking on **Apply** button after selecting a message handler.

Function definition will be added to the source file in the Pane 2 and the prototype under Message Handlers category in Pane 1.

Add Timer Handler

1. Select **Timer Handlers** category in the Pane 1 and right click.
2. A pop-up menu will be displayed.
3. Select **Add**. A dialog box appears.
4. Enter Timer Handler Name like e.g., "Time_One" and the Timer Value in milliseconds.
5. Select **OK** button.
6. Function definition will be added to the source file automatically in the Pane 2 and the prototype under Timer Handlers category in Pane 1.

Note:

- Adding a Sleep function inside a Timer handler might have an adverse effect on the application.
- Maximum of 16 timers can run simultaneously in cyclic mode. Anything above 16 will fail to start.

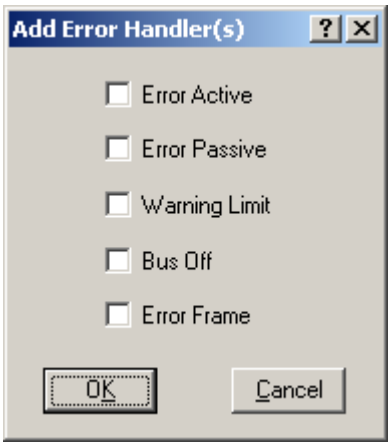
Add Key Handler

1. Select **Key Handlers** category in the Pane 1 and right click.
2. A pop-up menu will be displayed.
3. Select **Add**. A dialog box appears asking the user to press a key.
4. Press a key for which User want to write the handler. The same will be displayed in the dialog box.
5. Select **OK** button or **Apply** button if more key handlers are to be added from the same dialog.

Function definition will be added to the source file automatically in the Pane 2 and the prototype under Key Handlers category in Pane 1.

Add Error Handler

1. Select **Error Handlers** category in the Pane 1 and right click.
2. A pop-up menu will be displayed.
3. Select **Add**. A dialog as shown below pops up from this dialog select the type of error handlers to he handled by your program and click on **OK** button.



Function definition will be added to the source file automatically in the Pane 2 and the prototype under Error Handlers category in Pane 1.

Add DLL Handler

DLL handlers are invoked at the time of loading the DLL or while unloading the DLL. The procedure for adding DLL handlers is similar to that of adding error handlers.

Add Utility Function

1. Select **Utility Functions** category in the Pane 1 and right click.
2. A pop-up menu comes up.
3. Select **Add**. A dialog box appears.
4. Return Type of the utility function can be selected from the combo box or directly typed. The combo box will have primitive data types and database message structure names.
5. Enter the Function Prototype in the Edit control like e.g., "Func_One(int a, int b)".
6. Select **OK** button.

Function definition will be added to the source file automatically in the Pane 2 and the prototype under Utility Functions category in Pane 1.

Global Variables

To add/delete/modify global variables follow the steps given below.

1. Select **Global Variables** category in the Pane 1 and double click.
2. The Pane 3 will become editable and will show global variable block.
3. Change this block to Add/Delete/Modify the global variables.

Variable declaration will be added to the source file automatically in the Pane 2.

Note:

- Use global variable block to use macros, structure or union definitions. The scope of variables and definitions given in this block is throughout the program.

Edit Function Body

User can edit any function body by double clicking the prototype of the function displayed in Pane 1. On double click of the function prototype, the function body will be displayed in the Pane 3 and will be ready for editing.

Variable of Message Type

BUSMASTER defines structures for messages define in the database. User can use these structures while programming. Please follow the steps below to add variable of the message type

1. Edit the function for which database message name is to be added. (Refer: section Edit Function Body)

2. Right click in the Pane 3.
3. A pop-up menu is displayed.
4. Select **Insert Message**. A dialog box is displayed with all the database messages under Message list.
5. Choose a message from the list.
6. Select the check box option in the dialog box.
7. Click on **Select** button.

The selected message variable will be displayed in the Pane 3 and the same is updated in the Pane 2.

Insert Message name

User can add a tag of message structure and this could be used for defining variables. Please follow the steps below to insert a message structure tag into the function.

1. Edit the function for which database message name is to be added. (Refer: section Edit Function Body)
2. Right click in the Pane 3.
3. A pop-up menu is displayed.
4. Select **Insert Message**. A dialog box is displayed with all the database messages under Message list.
5. Choose a message from the list and click on **Select** button.
6. The selected message will be displayed in the Pane 3 and the same is updated in the Pane 2.

Insert Signal name

User can use signal names while programming. The signal names have to be used in conjunction with the corresponding message variable. It is member of message structure. Please follow the steps below to insert a signal name into the function.

1. Edit the function in which signal name is to be added. (Refer: section Edit Function Bodyedit_function_body)
2. Right click in the Pane 3. A pop-up menu is displayed.
3. Select **Insert Signal**. A dialog box is displayed with all the database messages under Message list.
4. Choose a message from the list. A list of signals will be displayed under Signals list.
5. Select a signal and click on **Select** button.
6. The selected signal will be displayed in the Pane 3 and the same is updated in the Pane 2.

Insert a Function

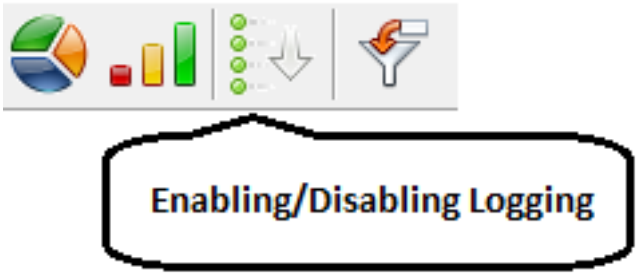
BUSMASTER provides API functions, which can used while programming. These functions can be used to interact with BUSMASTER application. Please follow the steps below to insert a function

1. Edit the function for which prototype is to be added. (Refer: Editing Function Body)
2. Right click in the Pane 3. A pop-up menu is displayed.
3. Select **Insert** Function. A dialog box is displayed with a set of function prototypes. (API Listing)
4. Choose required function prototype from the list and click on **OK** button.
5. The selected function prototype will be displayed in the Pane 3 and the same is updated in the Pane 2.

Message Log

CAN messages can be logged to a file for analysis and replay. Log file name shall be selected as described in section Log and Replay.

To start message logging select Log Start or press the Tool Bar Button shown in the figure below. The tool bar is toggle button. Clicking on the button or selecting the menu again will stop logging. Once the logging has started, the messages received and transmitted will be logged in to the file with time of message reception.



Note:

- Logging will fail if the log file is not present in the specified location.
- Logging status is stored in configuration file and logging will be started automatically during application startup if it is enabled and saved in the configuration file.

Replay

User can replay messages from a BUSMASTER log file. User can choose multiple log files for replay in different modes. Please find more details to configure replay in section Log and Replay.

The log file content can be filtered to choose interested messages alone. To add filters, select Filter option from Replay Configuration Window. Before starting replay, active filters will be applied on log file and resulting messages will be taken for replay.

Replaying a log file shall be done in two methods. That is

- Interactive and
- Non-Interactive

In interactive replay mode, the log file content will be display as list of messages and user can navigate this list and can transmit interested messages. User can step through replay messages, can skip messages, can start message transmission continuously and can insert break points.

In non interactive mode, replay will start during tool connect and will be stopped during tool disconnect. In case of cyclic mode the replay will continue till tool disconnect and in monoshot or once, all messages will be transmitted only once and replay will start.

Based on replay mode, user can configure replays in two different modes.

- Single Run Mode and
- Cyclic Mode

Please find more information on these modes on respective sections

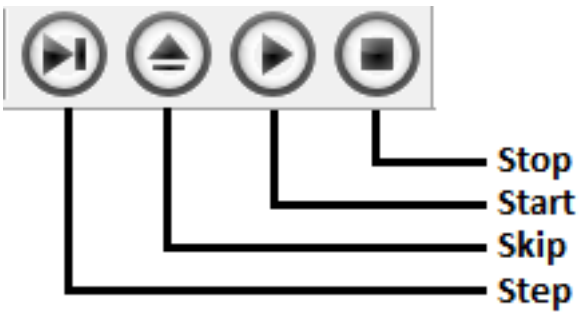
Cyclic Mode

Find more details to configure replay in cyclic mode in section Log and Replay.

Interactive Replay

In interactive replay mode, replay window will be displayed during connect. Follow the steps given below to start replay.

- Select a block of messages from Message Replay Window
- Select **CAN --> Replay --> Go** or tool bar button Go (shown in figure below) to start sending message cyclically one by one starting with first one in message block. Message replay window will be freezed. If mode is **Cyclic** then the selected messages from **Replay window** will be sent. By default only the first message will be selected. After sending all the selected messages it waits for the delay mentioned in **Delay between replay cycles**. Then the cycle will be repeated.
- Select **CAN --> Replay --> Stop** or Stop tool bar button (shown in figure below) to stop replay. Once the replay is stopped, Replay Message Window will be activated again.



Replay window will be closed during tool disconnect.

Non-Interactive Replay

In non-interactive replay mode, replay will start during tool connect. First filters will be applied on the messages from the log file.Then replay will start with the filtered set and will continue transmitting messages continuously. If a cycle of transmission is complete, next cycle of transmission will start after cyclic delay.

To stop all non-interactive replays, disconnect the tool.

Single Run Mode

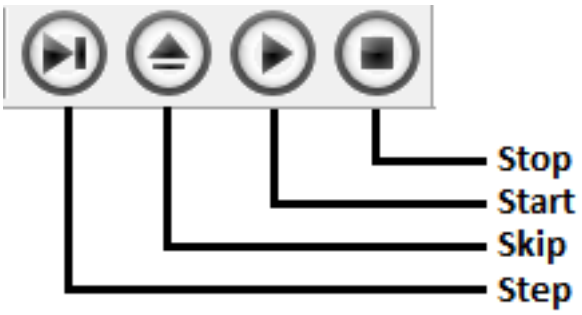
Find more details to configure replay in cyclic mode in section Log and Replay.

Interactive Replay

In interactive replay mode, replay window will be displayed during connect. Follow the steps given below to start replay.

- Select a message from Message Replay Window.
- There are four options to select
  - **CAN** > **Replay** > **Go**
  - **CAN** > **Replay** > **Step**
  - **CAN** > **Replay** > **Skip**
  - **CAN** > **Replay** > **Stop**

User can use tool bar button shown in figure below for this purpose.



Step

If User selects Step the current highlighted message will be sent over CAN bus and next message will be highlighted. If the current highlighted message is the last message in message replay window, then first message in the replay window will highlighted.

Skip

If User selects Skip the highlighted message will not be sent and next message will be highlighted. the current highlighted message is the last message in message replay window, then first message in the replay window will highlighted.

Go

If User selects Go then replay will start and message transmission will happen continuously with configured message delay. Replay message window will be freezed. Once replay finds break point or the last message is already transmitted, replay will stop. In case of break point, that line will be highlighted. If it is due to the last message transmission, then first message will be highlighted. Once the replay is stopped, replay message window will be activated again.

Stop

If user selects Stop, the replay of messages will be stopped. If replay is in the middle of message transmission, that message will be completely transmitted and then replay will stop. Once the replay is stopped, replay window will be activated again and next message of last transmitted message will be highlighted.

Break Points

Inserting break points in the replay messages enables user to transmit a section of messages and then go in to the step mode. Break points shall be inserted by just double clicking the message entry in the replay window. This is a toggling functionality. Double clicking again on the same message entry will disable break point.

Replay with Go option will stop at break point. This makes user to analyze the CAN communication better.

Note

- Break points are available only in interactive single run mode and will be considered in Go option only
- In case of Step, break points are ignored

Non-Interactive Replay

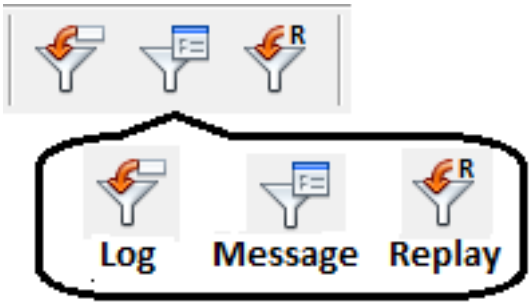
In non-interactive replay, message transmission will start from the beginning during tool connect. Message transmission will be stopped during tool disconnect.

Enable/Disable Filter

Filter (App Filter) can be enabled/disabled-using tool bar buttons or menu. Filters must have been configured prior to this. (Refer section Configure - App Filter and Display Filter).

Display Filter

To enable message window filtering select **CAN --> Message Window --> Enable Filters** or press **Display Filter** toolbar button shown in figure below.



To disable filtering select the toolbar button again. Filtering will toggle on each press.

Log Filter

To enabling filter for logging select **CAN --> Logging --> Enable Filters** or press **Log Filter** toolbar button shown in the fig. The filter will be applied on messages that are received after enabling the filter. To disable select the same menu item or toolbar button again. Filtering will toggle on each press.

Replay Filter

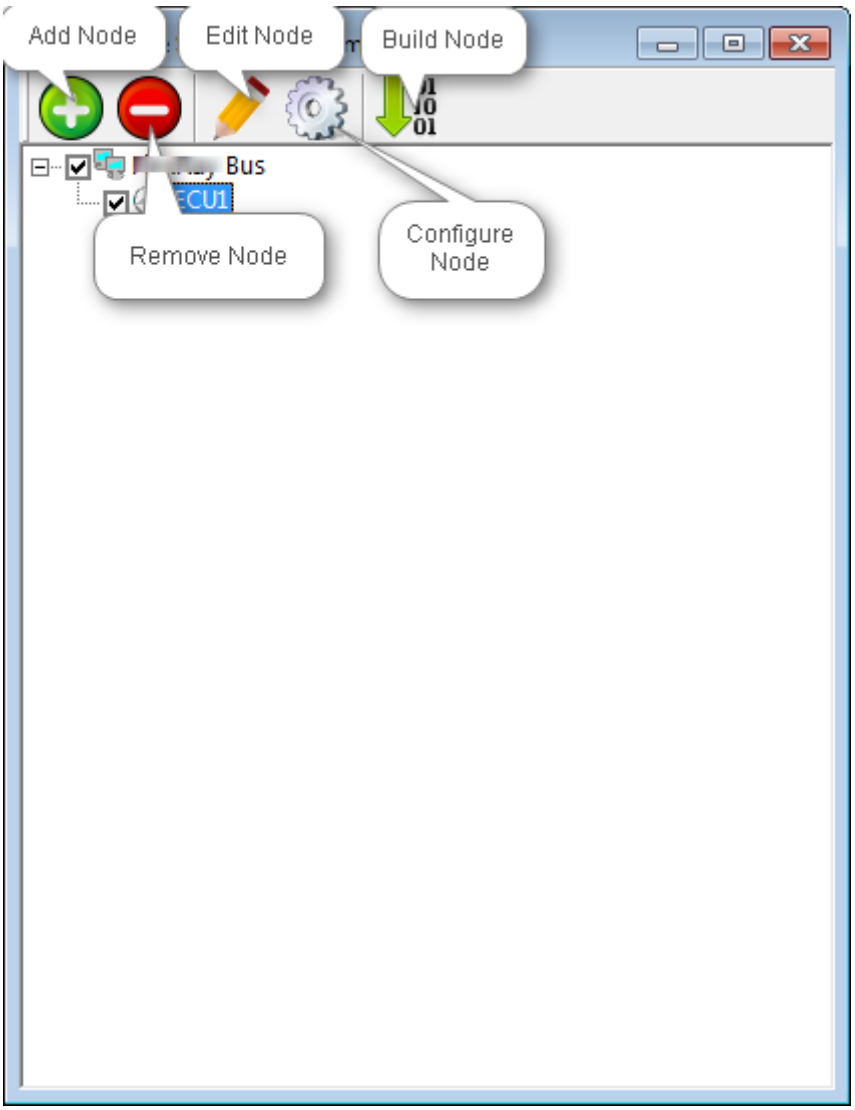
To enabling filter for replay select **CAN --> Replay --> Enable Filters** or press **Replay Filter** toolbar button shown in the fig. To disable select the same menu item or toolbar button again. Filtering will toggle on each press.

Note: Note

- Message filter and Log filter will be applied only for the incoming messages after enabling the filter.
- Filters can be Enabled/Disabled irrespective of tool connection status.

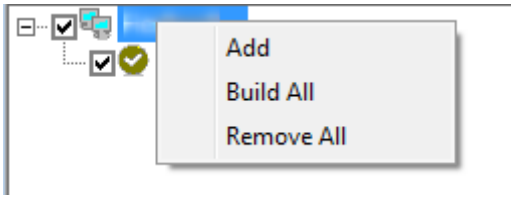
Node Simulation Configuration

Simulated systems can be configured under the <Protocol>-bus by following the steps given below. Select **<Protocol> --> Node Simulation --> Configure** menu option. This will display the window as shown is figure below.



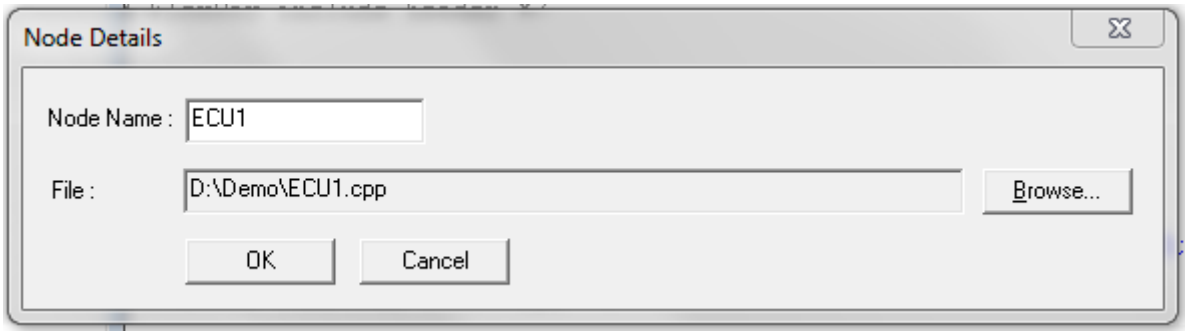
Add Node

This is used to added .cpp/.dll files to Node Simulation. Add Node can be done by following ways:



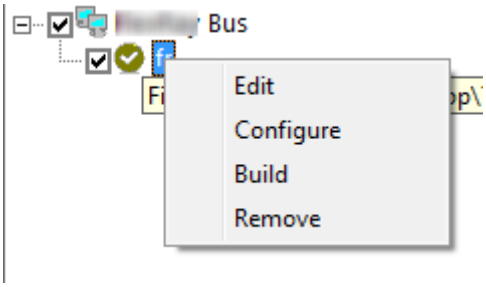
1. Right click the Root Node(<Protocol> Bus) and select "Add".
2. Click Add Node in the toolbar.
3. Pressing "Insert" key in the keyboard.

Then "Node Details" dialog box appears as shown below. Add unique Node name and add existing .cpp/.dll or provide new File name to create new .cpp file.



Edit Node

This is used to edit the .cpp file attached to a Node. Editing can be done by following ways:



1. Select the Node then Right click and select "Edit".
2. Select the Node and click "Edit Node" in the toolbar.
3. Select the Node and press "Enter" key in the keyboard.

Then "Function Editor" window appears in which the required editing can be done.

Remove Node

This is used remove selected node all the nodes in the Simulated system. Removing a Node can be done by following ways:

1. Select the Node then Right click and select "Remove". To Remove All Nodes select Root Node(<Protocol> Bus) and select "Remove All".
2. Select the Node and click "Remove Node" in the toolbar. To Remove All Nodes select Root Node(<Protocol> Bus) and select "Remove Node" in the toolbar.
3. Select the Node and press "Delete" key in the keyboard. To Remove All Nodes select Root Node(<Protocol> Bus) and press "Delete" key.

Configure Node

This is used change the name of the Node or change/add .cpp/.dll associated with a Node. Configuring a Node can be done by following ways:

1. Select the Node then Right click and select "Configure".
2. Select the Node and click "Configure Node" in the toolbar.
3. If no .cpp/.dll files are associated with the node previously, then by pressing "Enter" key in the keyboard.

Build Node

This is used build the .cpp files associated with selected Node or all the nodes in the Simulated System. Building a Node can be done by following ways:

1. Select the Node then Right click and select "Build". To Build All Nodes select Root Node(<Protocol> Bus) and select "Build All".
2. Select the Node and click "Build Node" in the toolbar. To Build All Nodes select Root Node(<Protocol> Bus) and select "Build All" in the toolbar.

Enable/Disable Node

This used to active/deactivate selected Node or all the Nodes in the Simulated System. Enabling/Disabling can be done by following ways:

1. Check/Uncheck the checkbox associated with the Node will Enable/Disable the Node respectively. To Enable/Disable all the Nodes Check/Uncheck the Root Node(<Protocol> Bus) respectively.
2. "Spacebar" key can be used as keyboard shortcut to Check/Uncheck the Node(s).

Note:

1. Node(s) can't be Added/Removed/Configured/Enabled/Disabled while the network is connected.
2. A Node can be edited while the network is connected. But the file must be built again to see the changes.

Node Simulation Examples

Node simulation supports both C and C++ compilation. Below are the examples in C++ for CAN and J1939.

J1939

```
/* This file is generated by BUSMASTER */
/* VERSION [1.1] */
/* BUSMASTER VERSION [1.7.0] */
/* PROTOCOL [J1939] */

/* Start J1939 include header */
#include <Windows.h>
#include <J1939Includes.h>

/* End J1939 include header */


/* Start J1939 global variable */

/* End J1939 global variable */


/* Start J1939 Function Prototype  */
GCC_EXTERN void GCC_EXPORT OnTimer_Timer_1000( );
GCC_EXTERN void GCC_EXPORT OnKey_q(unsigned char KeyValue);
GCC_EXTERN void GCC_EXPORT OnPGN_All(STJ1939_MSG* RxMsg);
GCC_EXTERN void GCC_EXPORT OnEvent_DataConf(UINT32 unPGN, BYTE bySrc, BYTE
 byDest, BOOL bSuccess);
GCC_EXTERN void GCC_EXPORT OnEvent_AddressClaim(BYTE byAddress);
int Utils_(int x,int y);
GCC_EXTERN void GCC_EXPORT OnDLL_Load();
GCC_EXTERN void GCC_EXPORT OnDLL_Unload();
GCC_EXTERN void GCC_EXPORT OnTimer_dew_10( );
GCC_EXTERN void GCC_EXPORT OnBus_Connect();
```

```
GCC_EXTERN void GCC_EXPORT OnBus_Disconnect();
GCC_EXTERN void GCC_EXPORT OnPGNID_100(STJ1939_MSG* RxMsg);
/* End J1939 Function Prototype  */

/* Start J1939 generated function - OnTimer_Timer_1000 */
void OnTimer_Timer_1000( )
{
STJ1939_MSG msg;

msg.m_sMsgProperties.m_byChannel = 1;
msg.m_sMsgProperties.m_eType = MSG_TYPE_DATA;
msg.m_sMsgProperties.m_eDirection = DIR_TX;

msg.m_sMsgProperties.m_uExtendedID.m_s29BitId.m_bySrcAddress = 5;

msg.m_unDLC = 5;
msg.m_pbyData = new BYTE[15];
BYTE tmp[] = {12, 34, 45, 56, 78};
memcpy(msg.m_pbyData, tmp, 5);
Trace("J1939 Time Handler");
SendMsg (&msg);
}/* End J1939 generated function - OnTimer_Timer_1000 */
/* Start J1939 generated function - OnKey_q */
void OnKey_q(unsigned char KeyValue)
{
STJ1939_MSG msg;

msg.m_sMsgProperties.m_byChannel = 1;
msg.m_sMsgProperties.m_eType = MSG_TYPE_DATA;
msg.m_sMsgProperties.m_eDirection = DIR_TX;

msg.m_sMsgProperties.m_uExtendedID.m_s29BitId.m_bySrcAddress = 5;

msg.m_unDLC = 5;
msg.m_pbyData = new BYTE[15];
BYTE tmp[] = {11, 22, 33, 44, 55};
memcpy(msg.m_pbyData, tmp, 5);

SendMsg (&msg);
}/* End J1939 generated function - OnKey_q */
/* Start J1939 generated function - OnPGN_All */
void OnPGN_All(STJ1939_MSG* RxMsg)
{
/* TODO */
Trace("MSG ALL");

STJ1939_MSG msg;

msg.m_sMsgProperties.m_byChannel = 1;
msg.m_sMsgProperties.m_eType = MSG_TYPE_DATA;
msg.m_sMsgProperties.m_eDirection = DIR_TX;

msg.m_sMsgProperties.m_uExtendedID.m_s29BitId.m_bySrcAddress = 5;

msg.m_unDLC = 8;
msg.m_pbyData = new BYTE[15];
BYTE tmp[] = {12, 34, 45, 56, 78};
memcpy(msg.m_pbyData, tmp, 5);
SendMsg (&msg);
}/* End J1939 generated function - OnPGN_All */
/* Start J1939 generated function - OnEvent_DataConf */
void OnEvent_DataConf(UINT32 unPGN, BYTE bySrc, BYTE byDest, BOOL bSuccess)
{
/* TODO */
Trace("Data Handler");
}/* End J1939 generated function - OnEvent_DataConf */
/* Start J1939 generated function - OnEvent_AddressClaim */
void OnEvent_AddressClaim(BYTE byAddress)
```

```
{
/* TODO */
Trace("Address Claim Event");
}/* End J1939 generated function - OnEvent_AddressClaim */
/* Start J1939 generated function - Utils_ */
int Utils_(int x,int y)
{
/* TODO */
}/* End J1939 generated function - Utils_ */
/* Start J1939 generated function - OnDLL_Load */
void OnDLL_Load()
{
Trace("Dll has been loaded");
/* TODO: Define and Initialise the following variables*/
 UINT ReturnValue ;
ReturnValue = EnableLogging();

}/* End J1939 generated function - OnDLL_Load */
/* Start J1939 generated function - OnDLL_Unload */
void OnDLL_Unload()
{
Trace("Dll is unloaded");
/* TODO: Define and Initialise the following variables*/
 UINT ReturnValue ;
ReturnValue = DisableLogging();

}/* End J1939 generated function - OnDLL_Unload */
/* Start J1939 generated function - OnTimer_dew_10 */
void OnTimer_dew_10( )
{
STJ1939_MSG msg;

msg.m_sMsgProperties.m_byChannel = 1;
msg.m_sMsgProperties.m_eType = MSG_TYPE_DATA;
msg.m_sMsgProperties.m_eDirection = DIR_TX;

msg.m_sMsgProperties.m_uExtendedID.m_s29BitId.m_bySrcAddress = 5;

msg.m_unDLC = 5;
msg.m_pbyData = new BYTE[15];
BYTE tmp[] = {12, 34, 45, 56, 78};
memcpy(msg.m_pbyData, tmp, 5);
Trace("J1939 Time Handler");
SendMsg (&msg);
}/* End J1939 generated function - OnTimer_dew_10 */
/* Start J1939 generated function - OnBus_Connect */
void OnBus_Connect()
{
Trace("Bus Disconnected");
}/* End J1939 generated function - OnBus_Connect */
/* Start J1939 generated function - OnBus_Disconnect */
void OnBus_Disconnect()
{
Trace("Bus Disconnected");
}/* End J1939 generated function - OnBus_Disconnect */
/* Start J1939 generated function - OnPGNID_100 */
void OnPGNID_100(STJ1939_MSG* RxMsg)
{
Trace("MSG ALL");

STJ1939_MSG msg;

msg.m_sMsgProperties.m_byChannel = 2;
msg.m_sMsgProperties.m_eType = MSG_TYPE_DATA;
msg.m_sMsgProperties.m_eDirection = DIR_TX;

msg.m_sMsgProperties.m_uExtendedID.m_s29BitId.m_bySrcAddress = 5;
```

```
msg.m_unDLC = 8;
msg.m_pbyData = new BYTE[15];
BYTE tmp[] = {18, 58, 45, 56, 11};
memcpy(msg.m_pbyData, tmp, 5);
SendMsg (&msg);
}/* End J1939 generated function - OnPGNID_100 */
```

CAN

```
/* This file is generated by BUSMASTER */
/* VERSION [1.1] */
/* BUSMASTER VERSION [1.7.0] */
/* PROTOCOL [CAN] */

/* Start BUSMASTER include header */
#include <Windows.h>
#include <CANIncludes.h>

/* End BUSMASTER include header */


/* Start BUSMASTER global variable */

/* End BUSMASTER global variable */


/* Start BUSMASTER Function Prototype  */
GCC_EXTERN void GCC_EXPORT OnMsg_All(STCAN_MSG RxMsg);
GCC_EXTERN void GCC_EXPORT OnKey_d(unsigned char KeyValue);
GCC_EXTERN void GCC_EXPORT OnError_Warning_Limit(SCAN_ERR ErrorMsg);
GCC_EXTERN void GCC_EXPORT OnDLL_Load();
GCC_EXTERN void GCC_EXPORT OnDLL_Unload();
GCC_EXTERN void GCC_EXPORT OnTimer_new_100( );
GCC_EXTERN void GCC_EXPORT OnBus_Connect();
GCC_EXTERN void GCC_EXPORT OnBus_Disconnect();
/* End BUSMASTER Function Prototype  */

/* Start BUSMASTER generated function - OnMsg_All */
void OnMsg_All(STCAN_MSG RxMsg)
{
// Initialise message structure
RxMsg.m_unMsgID = 0x100;              // Message ID
RxMsg.m_ucEXTENDED = FALSE;           // Standard Message type
RxMsg.m_ucRTR = FALSE;                // Not RTR type
RxMsg.m_ucDLC = 8;                    // Length is 8 Bytes
RxMsg.m_sWhichBit.m_aulData[0] = 10;  // Lower 4 Bytes
RxMsg.m_sWhichBit.m_aulData[1] = 20;  // Upper 4 Bytes
RxMsg.m_ucChannel = 1;
SendMsg(RxMsg);

}/* End BUSMASTER generated function - OnMsg_All */
/* Start BUSMASTER generated function - OnKey_d */
void OnKey_d(unsigned char KeyValue)
{
 Connect();
}/* End BUSMASTER generated function - OnKey_d */
/* Start BUSMASTER generated function - OnError_Warning_Limit */
void OnError_Warning_Limit(SCAN_ERR ErrorMsg)
{
Trace("Warning Limit reached");
}/* End BUSMASTER generated function - OnError_Warning_Limit */
/* Start BUSMASTER generated function - OnDLL_Load */
void OnDLL_Load()
{
/* TODO: Define and Initialise the following variables*/

 EnableLogging();
```

```
}/* End BUSMASTER generated function - OnDLL_Load */
/* Start BUSMASTER generated function - OnDLL_Unload */
void OnDLL_Unload()
{
/* TODO: Define and Initialise the following variables*/
 DisableLogging();

}/* End BUSMASTER generated function - OnDLL_Unload */
/* Start BUSMASTER generated function - OnTimer_new_100 */
void OnTimer_new_100( )
{
// Initialise message structure
STCAN_MSG sMsg;

sMsg.m_unMsgID = 0x20;              // Message ID
sMsg.m_ucEXTENDED = FALSE;           // Standard Message type
sMsg.m_ucRTR = FALSE;                // Not RTR type
sMsg.m_ucDLC = 8;                    // Length is 8 Bytes
sMsg.m_sWhichBit.m_aulData[0] = 10;  // Lower 4 Bytes
sMsg.m_sWhichBit.m_aulData[1] = 20;  // Upper 4 Bytes
sMsg.m_sWhichBit.m_aulData[2] = 30;  // Upper 4 Bytes
sMsg.m_ucChannel = 1;
SendMsg(sMsg);
}/* End BUSMASTER generated function - OnTimer_new_100 */
/* Start BUSMASTER generated function - OnBus_Connect */
void OnBus_Connect()
{
Trace("Bus connected");
}/* End BUSMASTER generated function - OnBus_Connect */
/* Start BUSMASTER generated function - OnBus_Disconnect */
void OnBus_Disconnect()
{
Trace("Bus Disconnected");
}/* End BUSMASTER generated function - OnBus_Disconnect */
```

Database Editor

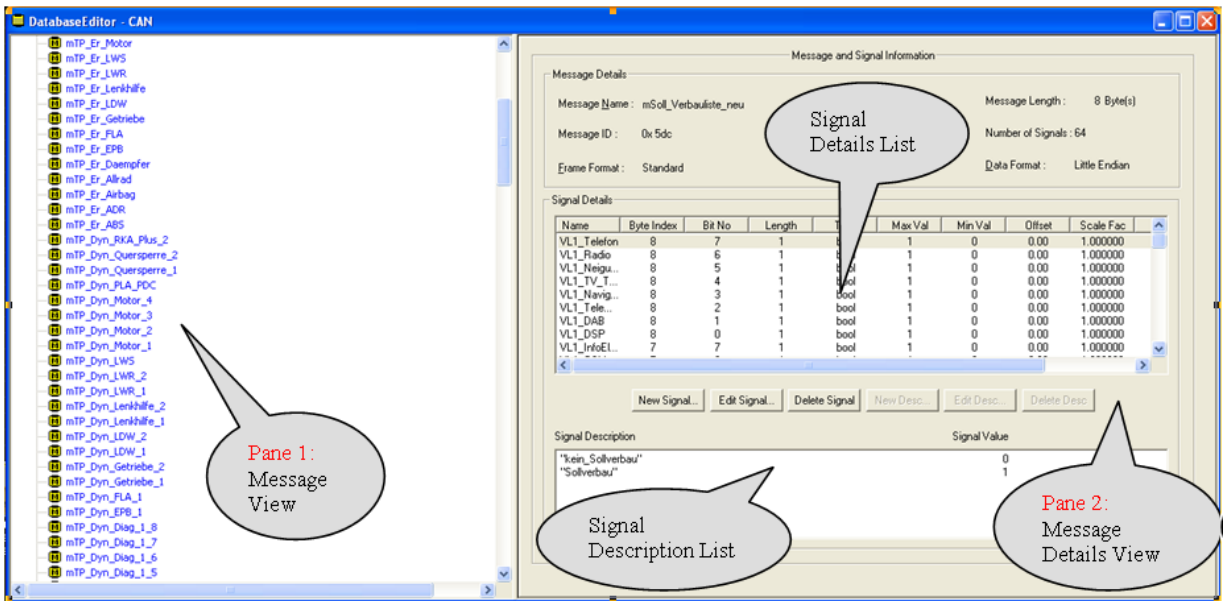
BUSMASTER database consists of information about expected message. You can create a database of messages to be transmitted or received over CAN bus. Each message has a unique ID and name. Each message has upto eight bytes of data. You can define the length of message in bytes. Each message can consist of one or more signals. In a message each signal has start bit and length, no two signals can overlap. Signal can have an offset, a multiplication factor and engineering units. These three information together are used to display signal value received in engineering units. The data received is multiplied by the factor, added to the offset to obtain the engineering value. Also a particular value of the signal can be given a meaningful name by using signal descriptor (e.g. ON = 1, OFF = 0). This information will be used while interpreting the messages.

User can create new BUSMASTER database by selecting **CAN --> Database --> New** menu option. This menu option will be enabled only when no database editor is open.

User can also open any BUSMASTER database by selecting **CAN --> Database --> Open** menu option.

This will allow you to specify the database name, which you want to open and edit.

There are two panes in the database editor as shown in figure below.



Left Pane

This will have the names of all messages listed in a tree fashion. Will be called Pane 1.

Right Pane

This pane will display the details of each message that you select from the Pane1. Will be called Pane 2.

By default no database is loaded. Once the user imports a database it will be stored across sessions. This is called the active database, which will be used for interpretation and by the function editor.

Import Database

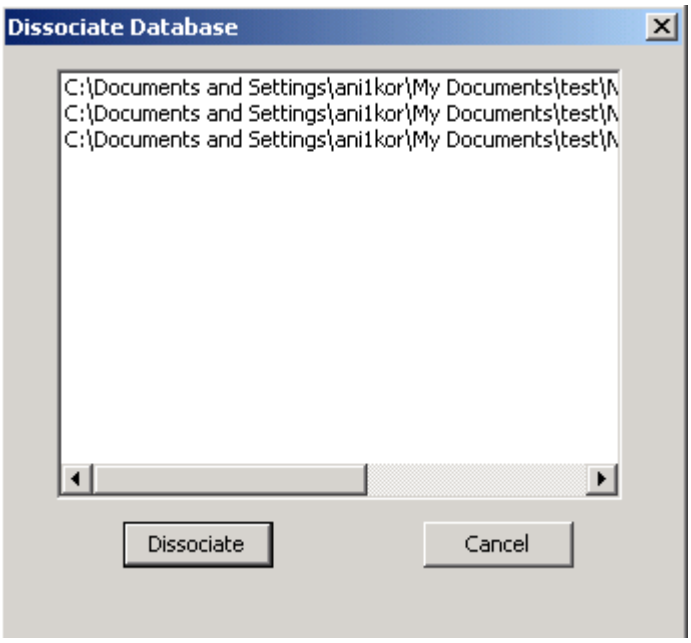
User can select any number of BUSMASTER generated database and make them as active databases.

1. Select **CAN --> Database --> Associate** menu option. An open file dialog will be displayed.
2. Select the databases and click on Open button.

Dissociate Database

User can Dissociate any number of active database from the application.

1. Select **CAN --> Database --> Dissociate** menu option. Following dialog box will be displayed:



2. Select the databases and click on Dissociate button.

Add Message

User can add new messages to the database following the steps given below

1. Select root item in Pane 1 and right click.
2. A pop-up menu will be displayed.
3. Select New Message menu option.
4. A dialog box will be displayed.
5. Key in all the details and select OK button.

The new message name is added as last item in the Pane 1 and the details are displayed in the Pane 2.

Edit Message

User can edit messages in database by following the steps given below

1. Select message name to be edited in Pane 1 and right click.
2. A pop-up menu will be displayed.
3. Select Edit Message menu option.
4. A dialog box will be displayed with all the message attributes displayed.
5. Key in all the details and select OK button.

The new message name will be added as last item in the Pane 1 and the details are displayed in the Pane 2.

Delete Message

User can delete messages in database by following the steps given below

1. Select message name to be deleted in Pane 1 and right click.
2. A pop-up menu will be displayed.
3. Select Delete menu option.
4. A delete confirmation message will be displayed.
5. Select Yes.

The message name is deleted from Pane 1 and the details are displayed in the Pane 2.

Add Signal

Message consists of signals. To define a signal in message follow steps given below

1. Click the message name for which you want to add the signal from the Pane 1.
2. The details of the message will be displayed in the Pane 2.
3. Right click in the signal details list in Pane 2.
4. A pop-up menu will be displayed.
5. Select New Signal menu option.
6. A signal details dialog box will be displayed.
7. Key in the signal details and click on OK button.

The new signal and its attributes are displayed in the signal details list. Selecting New Signal button will do the same.

Edit signal attributes

User can edit the attribute of a signal define earlier, please follow the steps below to do so

1. Click the message name for which you want to edit the signal attributes from the Pane 1. The details will be displayed in the Pane 2.
2. Select the signal in the signal details list in Pane 2.
3. Right click. A pop-up menu will be displayed.
4. Select Edit Signal menu option.
5. A signal details dialog box will be displayed.
6. Key in the signal details and click on OK button.

The changes are displayed in the signal details list for the selected signal. Selecting the signal details from the list and clicking on Edit Signal button will do the same.

Deleting a signal

User can edit the attribute of a signal define earlier, please follow the steps below to do so

1. Click the message name for which you want to delete the signal from the Pane 1.
2. The details will be displayed in the Pane 2.
3. Select the signal in the signal details list in Pane 2.
4. Right click. A pop-up menu will be displayed.
5. Select Delete menu option. A delete confirmation message will be displayed.
6. Select Yes.

The signal and its attributes are deleted from signal details list in Pane 2. Selecting the signal details from the list and clicking on Delete Signal button will do the same.

Add Signal description

User can add the give description for a value of a signal , please follow the steps below to do so

1. Click the message name for which you want to add description for the signal from the Pane 1. The details will be displayed in the Pane 2.
2. Select the signal in the signal details list in Pane 2.
3. Right click. A pop-up menu will be displayed.
4. Select Add Description menu option. A dialog box will be displayed.
5. Enter description and the signal value and click on OK button.

The new signal description and value are displayed in the signal description list. Selecting the signal details from the list and clicking on New Desc button can do the same.

Edit Signal Description and Signal value

User can edit the give description for the value of a signal, please follow the steps below to do so

1. Click the message name for which you want to edit description for the signal from the Pane 1.
2. The details will be displayed in the Pane 2.
3. Select the signal description and value from the signal description list in Pane 2.
4. Right click. A pop-up menu will be displayed.

5. Select Edit Description menu option. A dialog box will be displayed.
6. Enter description and the signal value and click on OK button.

The changes in signal description and value are displayed in the signal description list. The same can be done by selecting the signal details from the list and the description to be edited and by clicking on Edit Desc button.

Delete

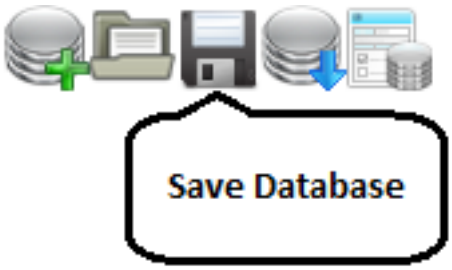
User can delete Signal description and Signal value by following the steps given below

1. Click the message name for which you want to delete description for the signal from the Pane 1. The details will be displayed in the Pane 2.
2. Select the signal description and value from the signal description list in Pane 2.
3. Right click. A pop-up menu will be displayed.
4. Select Delete Description menu option.
5. A delete confirmation message will be displayed.
6. Click on Yes button.

The selected signal description and value are deleted from the signal description list. The same can be done by selecting the signal details from the list and the description to be deleted and by clicking on Delete Desc button.

Save database

User can save the database to a file by selecting **CAN --> Database --> Save** or by clicking on the tool bar button shown below.



User also have an option to save the file at different folder location with different name. You can do this by following the steps given below.

1. Select **CAN** > **Database** > **Save As** menu option.
2. A save as file dialog box will be displayed. Enter the file name. Click on Save button.

Closing database editor

Select **CAN** > **Database** > **Close** menu option to close any opened database file. Or click on [X] button at the right upper corner of the database window.

Message Window

BUSMASTER reports all kinds of messages through this window. A message can arise from any one of the two categories as mentioned below

- Message transmitted across the CAN bus, including the one generated by BUSMASTER.
- Error messages

Each message is displayed in a separate line, which consists of the following five fields listed below respectively

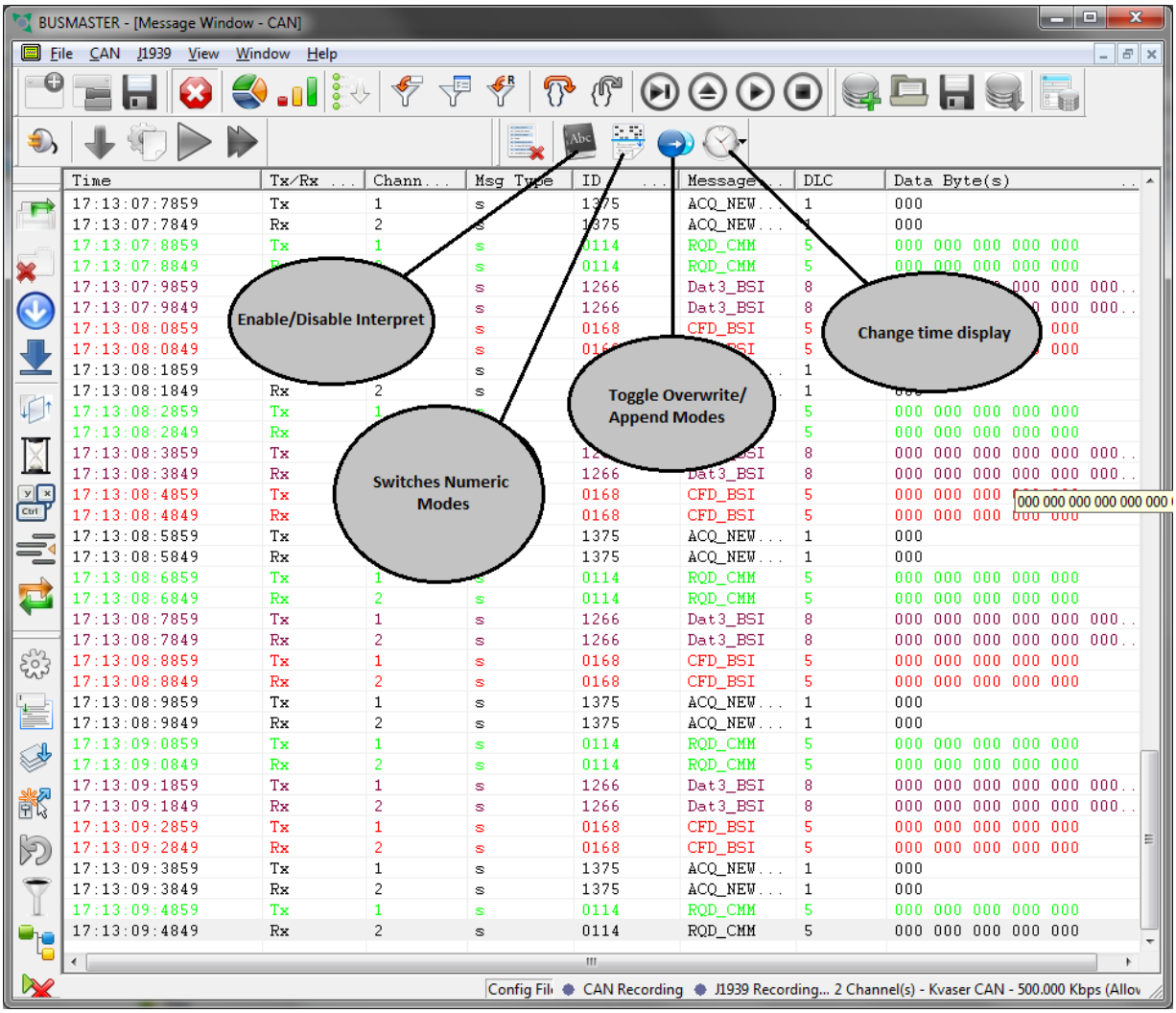
- Time – Time can be viewed in three different modes, namely
  - System – In this mode, message will be displayed with PC/System time.
  - Relative – In this mode, message will be displayed with time since the reception of the message with same identifier previously.

- Absolute – In this mode, the reference is the time of connection. Messages will be displayed with time since the logical connection with the device(ES581) is established.

In all cases time format is maintained as HH: MM: SS: MS where MS stands for millisecond, and the display will be in 24-hour scale.

- Tx/Rx - A message transmitted from BUSMASTER is tagged as Tx whereas for a received one the tag is Rx.
- Type – The indicates if the message is of standard, extended or RTR type, the convention followed is
  - S – Standard frame
  - X – Extended frame
  - Sr – Standard RTR frame
  - Xr – Extended RTR frame
- Message - This section contains the message ID. However, BUSMASTER enables to attribute a message with a specified name and color. If a particular message code is attributed with a name and a color, message name will appear in place of message ID and the message will be displayed in the specified color.
- DLC – It is abbreviation for data length count. It shows number of data bytes in the message body.
- Data Byte(s) – The data bytes are displayed either in hexadecimal or in decimal mode. Please refer to section Toggle numeric mode to know how to toggle numeric modes. On occurrence of an error a suitable error message will be displayed in red color

The following subsections describe various toolbar buttons used to change display of message entry.



Change Time Display

This is a tool bar button which pops out a menu with three options System, absolute and relative time mode display.

Toggle Message Overwrite

This is a toggle tool bar button. This button is used to switch between message overwrite mode and append mode. In message overwrite mode there will be only one instance of a message ID in the message window. Subsequent messages received with the same ID will overwrite the message entry. In append mode a newly added message entry will be appended instead. Please refer to description B of the figure shown in section Message Window.

Toggle Numeric Mode

This is a toggle tool bar button. This button is used to switch between decimal mode and hexadecimal mode. In decimal mode data bytes will be displayed in decimal format. In hexadecimal mode data bytes will be displayed in hexadecimal format. By default massages will be displayed in hexadecimal mode. Please refer to description C of the figure shown in section Message Window.

Toggle Message Interpretation

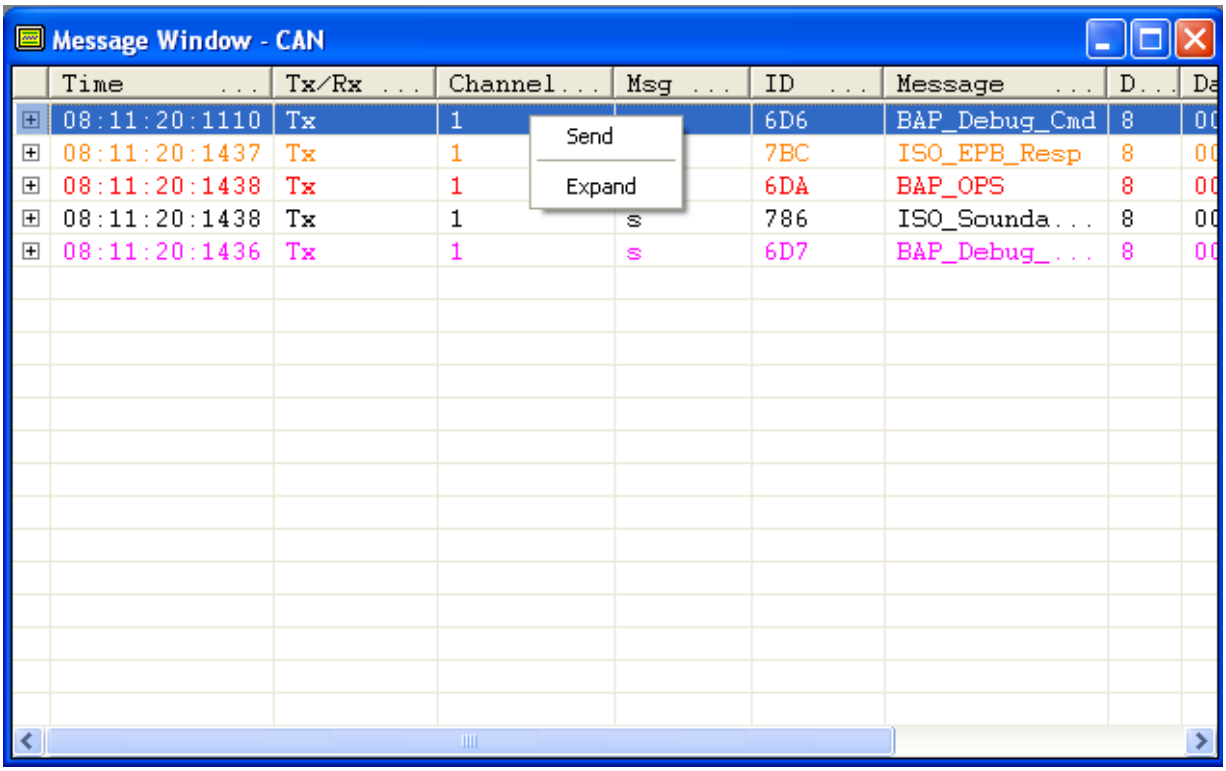
This is a toggle tool bar button. This button is used either to enable or disable message on-line interpretation. This button is enabled only in message overwrite mode. If on-line interpretation of message is enabled, a message entry will be followed by a textual description of the received message. Please refer to description D of the figure shown in section Message Window

The aforementioned will be done only if the message ID is found in the database. Else the message will be followed by a notification message stating “message not found in the database”.

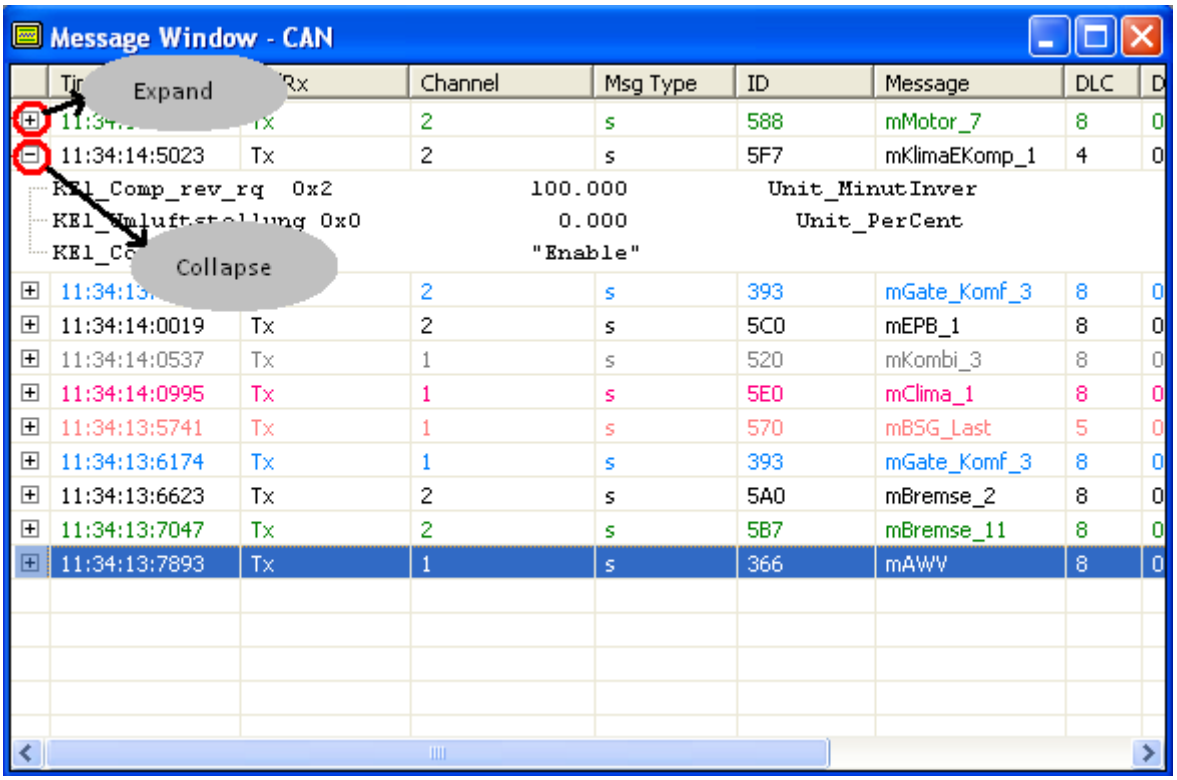
Message interpretation can be obtained by double clicking on the message.

Selective Message Interpretation

Messages can be selectively interpreted in overwrite display mode. Select a database message entry and right click. BUSMASTER will popup this menu.

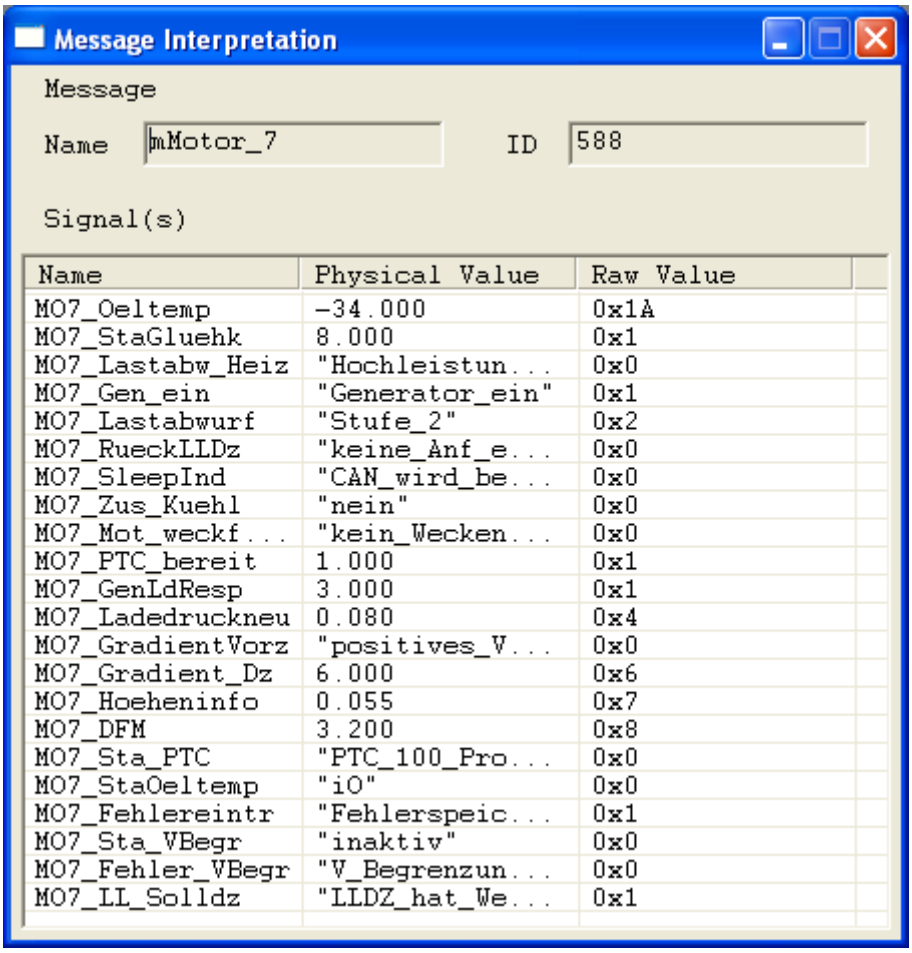


Select Expand to expand the message entry with its signal value. Signal values will be displayed in terms Raw and Physical values. The expanded entries can be closed by right clicking on that entry and selecting Collapse. The expanded entries can be closed by right clicking on that entry and selecting Collapse. Alternatively we can click on the '+' sign shown against each interpretable message to expand the message entry And clicking on the '-' sign will collapse the expanded entries as shown in figure below.



Interpretation Dialog

A message can be interpreted separately in a popup window using Interpretation dialog. Double clicking a message entry will show interpretation dialog with the message details. This will have a list of signals and its Raw and Physical Values.



Name	Physical Value	Raw Value
MO7_Oeltemp	-34.000	0x1A
MO7_StaGluehk	8.000	0x1
MO7_Lastabw_Heiz	"Hochleistun...	0x0
MO7_Gen_ein	"Generator_ein"	0x1
MO7_Lastabwurf	"Stufe_2"	0x2
MO7_RueckLLDz	"keine_Anf_e...	0x0
MO7_SleepInd	"CAN_wird_be...	0x0
MO7_Zus_Kuehl	"nein"	0x0
MO7_Mot_weckf...	"kein_Wecken...	0x0
MO7_PTC_bereit	1.000	0x1
MO7_GenLdResp	3.000	0x1
MO7_Ladedruckneu	0.080	0x4
MO7_GradientVorz	"positives_V...	0x0
MO7_Gradient_Dz	6.000	0x6
MO7_Hoeheninfo	0.055	0x7
MO7_DFM	3.200	0x8
MO7_Sta_PTC	"PTC_100_Pro...	0x0
MO7_StaOeltemp	"iO"	0x0
MO7_Fehlereintr	"Fehlerspeic...	0x1
MO7_Sta_VBegr	"inaktiv"	0x0
MO7_Fehler_VBegr	"V_Begrenzun...	0x0
MO7_LL_Solldz	"LLDZ_hat_We...	0x1

Left clicking on the message entry will change the message selection.

Sending a Message From Message Display

Messages can be directly send from Message Display entry. Select a message entry and right click. This will popup message operation menu (Refer Fig.1). Select Send to transmit the selected message entry on the CAN bus.

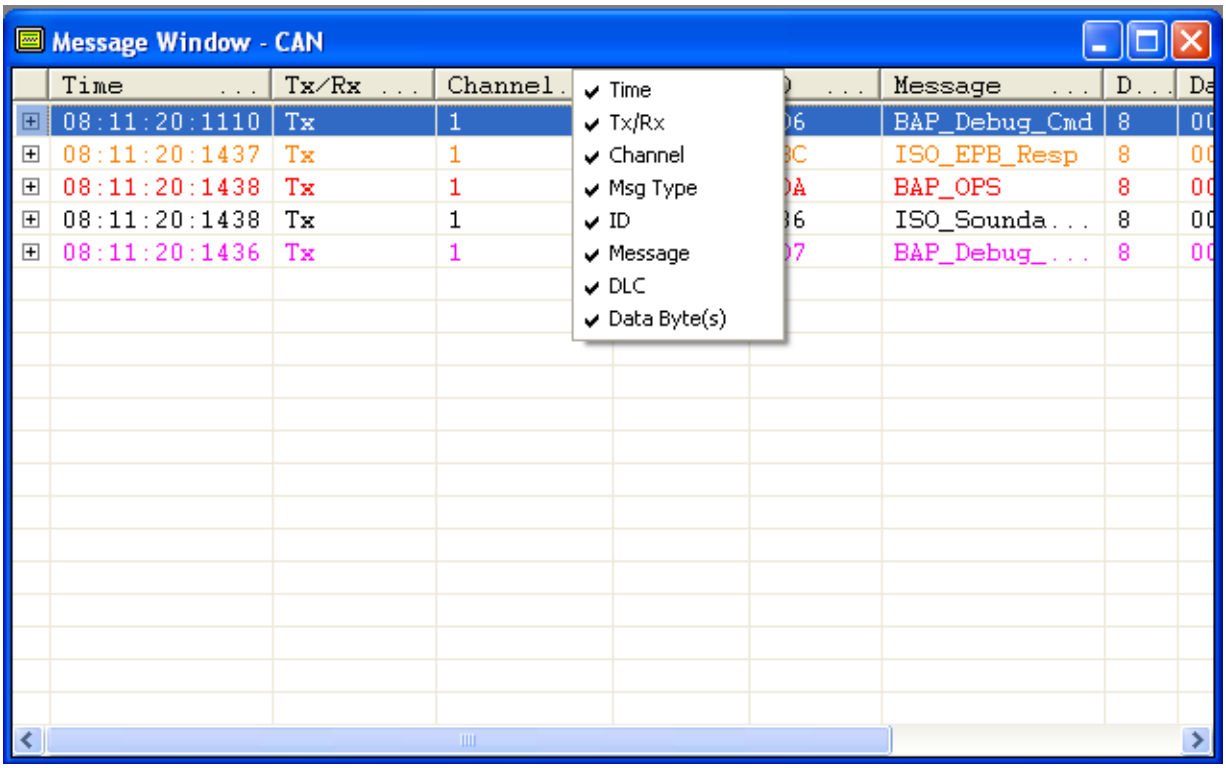
Clear Message Window

On pressing the tool bar button shown below the message window will be cleared.

Message Columns Ordering and visibility

Message columns can be dragged and dropped to any column position in the message window according to user's preference. The columns can also be shown or hidden. To show/ hide a column, right click on the columns header, a popup menu with all the column header names will be shown as shown in fig. 6 below. The columns which are currently shown are marked with a check mark against them in this menu. If user wishes to hide a column, just uncheck that column from the menu and the column will be hidden.

These column ordering and visibility are saved along with configuration.



Signal Generation

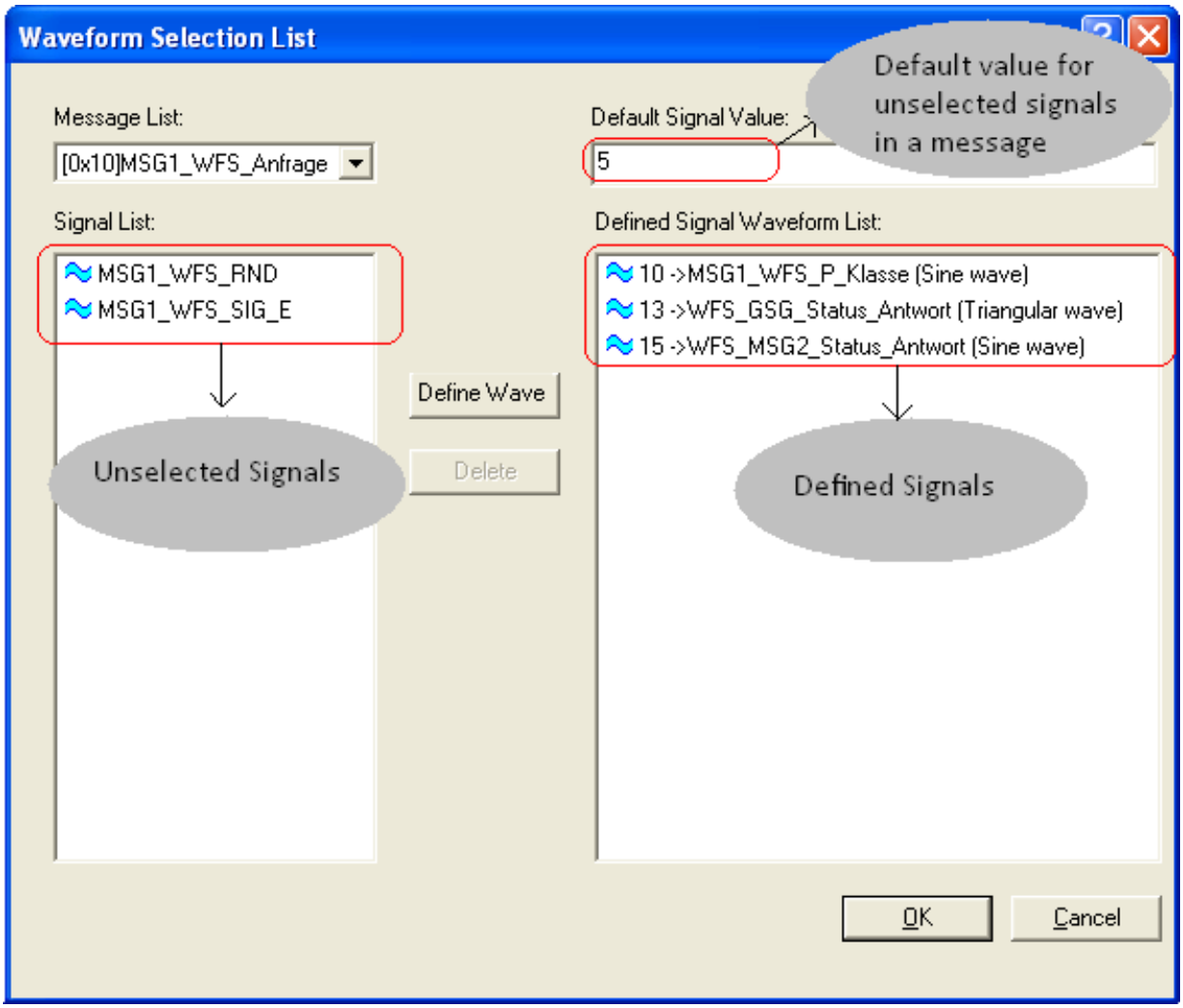
Signal Generation allows the user to configure each signal in database messages with particular waveform and send the messages with these signal values at a particular sampling time period..

Each Signal can have different waveform settings allotted like Signal type, Amplitude, Frequency.

All the signals will be having a standard sampling time at which their amplitude will be calculated depending on the wave type and they will be sent out.

Currently only two waveforms are supported, Sine Wave and Triangular Wave.

To configure signals, go to menu option, **CAN --> Signal Graph --> Configure** and user will be shown with the following dialog box.



The above shown figure contains the list of all the messages in a combo box, “Message list:” which are present in currently selected database file.

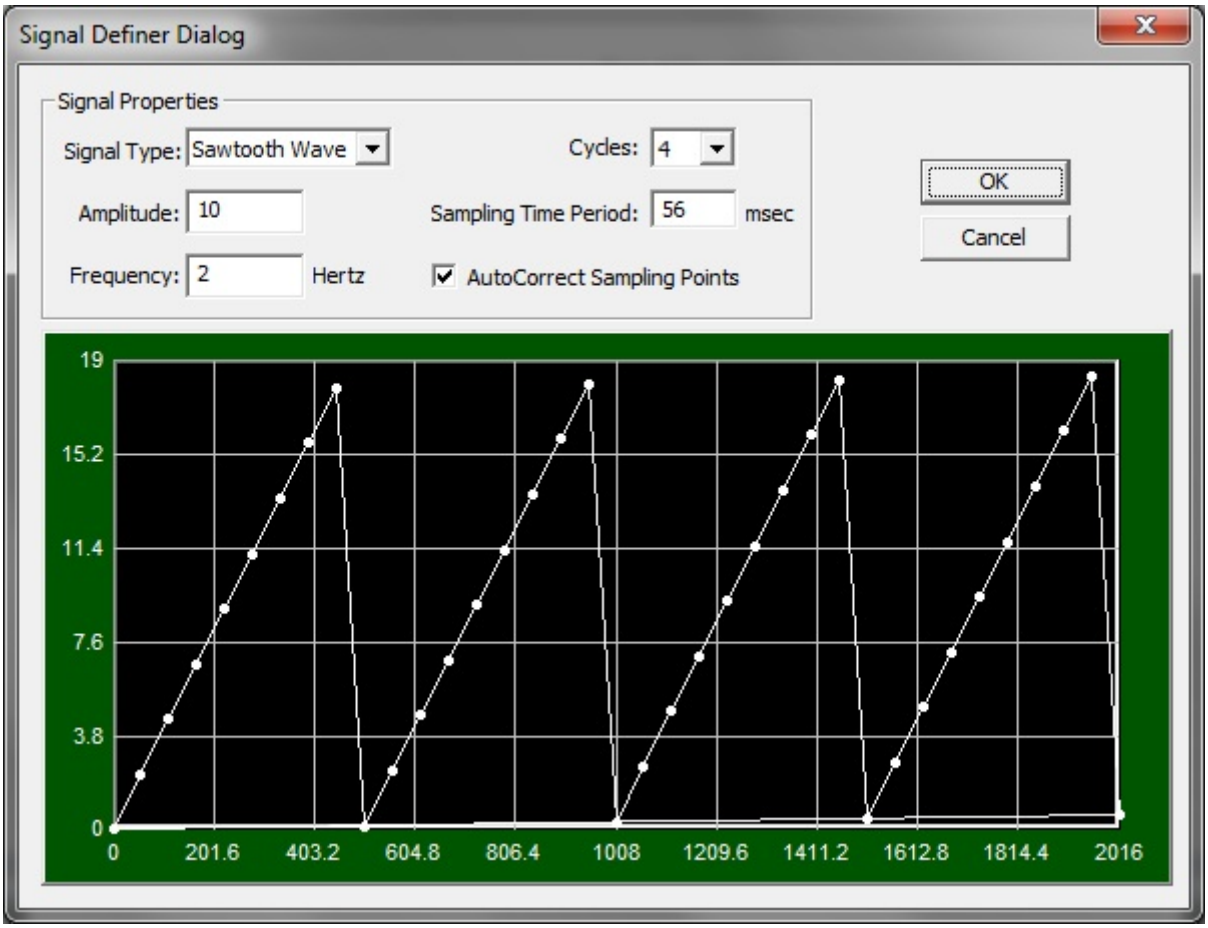
“Signal List” List control shows the signals in currently selected message in combo box which are not defined with any waveform.

“Defined Signal Waveform List” List control shows all the signals in different messages for which the waveforms are defined.

Use the “Define Wave” button to define a waveform for a particular signal. Alternatively double click on the unselected signals can be used to do the same. When user triggers this event, the following dialog pops out.

Currently there are 4 types of waves supported:

1. Sine Wave
2. Cos Wave
3. Triangular Wave
4. Sawtooth Wave



The dialog will be loaded with default waveform settings i.e. a sine wave with amplitude 10, frequency 1 and sampling time period 125. User can make appropriate changes to the wave by choosing signal type, desired amplitude and frequency. “Ok” button click will add the signal to Defined signals list.

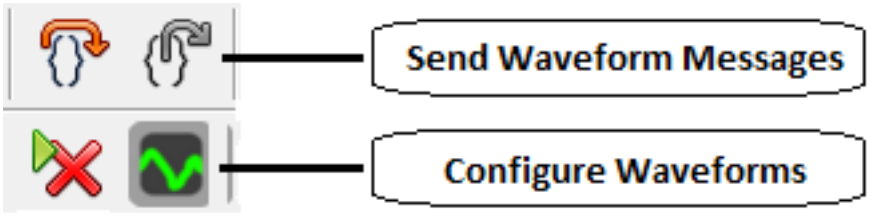
The sampling Time Period which is last modified will be applicable to all the signals. For example, if for first signals you choose the sampling time period as 125 and for the second signal, you choose the sampling time period as 100. Then the sampling time period applicable is 100 for first and second signals.

"AutoCorrect Sampling Points" checkbox when checked, will calculate the sampling time period for a given frequency such that there will be at least 8 points in the a cycle and the graph does not distort.

Maximum frequency that can be set is 125 and Sampling Time Period is 32767

Now, if user wants to transmit the defined signals, make sure the application is in connected state and use the menu option **CAN --> Waveform Messages --> Enable**.

Alternatively user can use the toolbar items shown below for configuring and sending waveform signals.

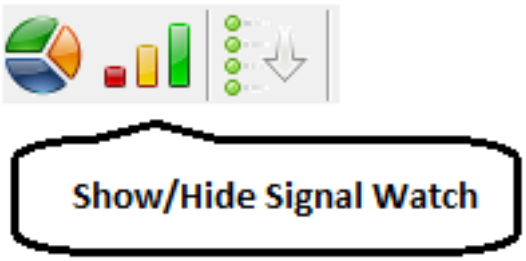


Use the “Delete” button in Fig. 1 to delete previously configured signals defined signals list.

The Waveform Signals defined are saved along with configuration.

Signal Watch

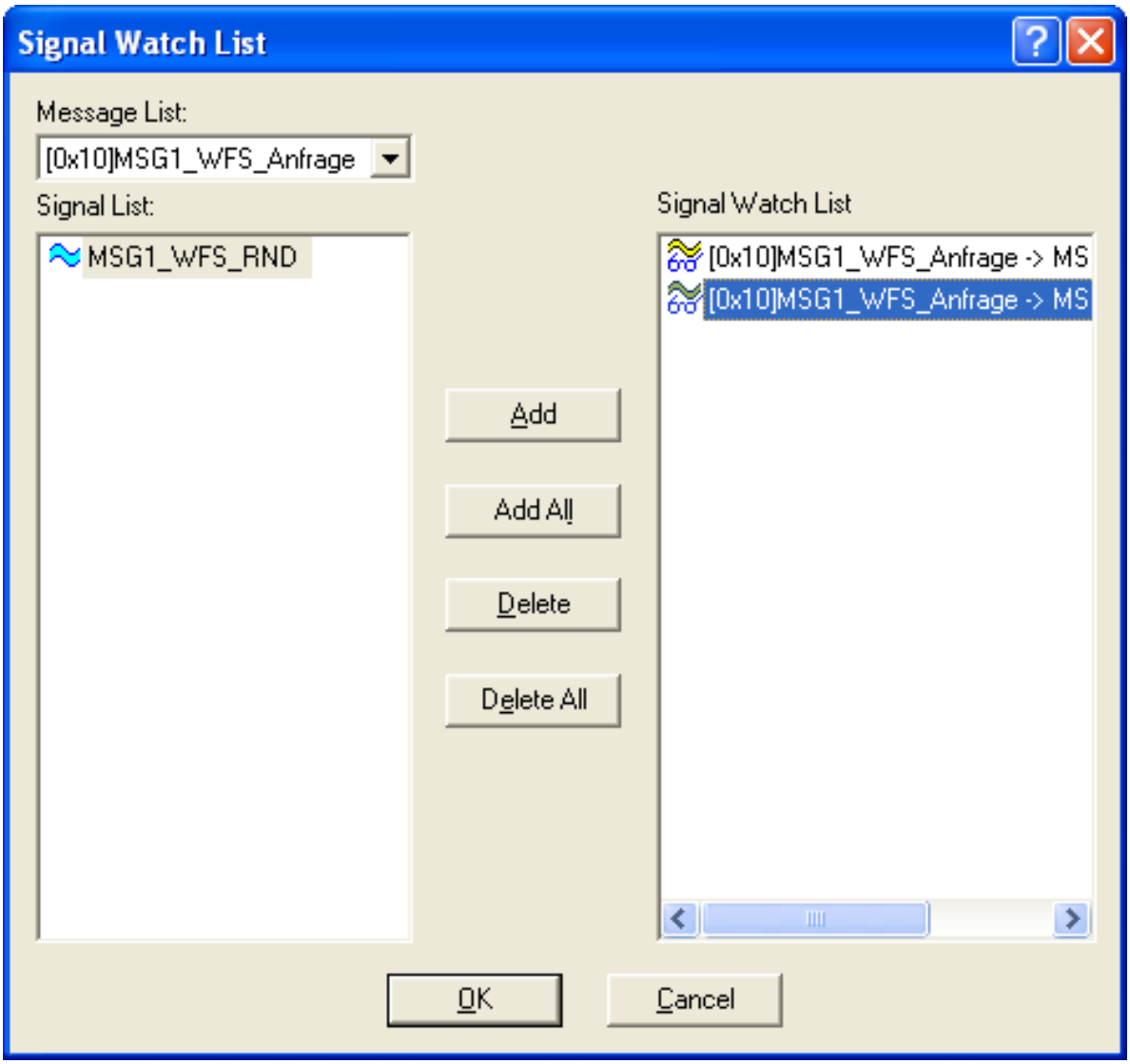
User can watch the value of a signal using the signal watch window as and when a message having that signal is received. The Physical and Raw values will be listed and updated as and when the message arrives. Click on the tool bar button shown below to display the signal watch window.



Add/ Delete Signals

Signal watch list can be interactively populated. The following list describes the steps to Add/Delete signals from Signal Watch List.

- Click on **CAN --> Signal Watch --> Configure**.
- A dialog box will be displayed with all the database messages listed under the Message list and the list of signals defined in the selected message. The Signal Watch List will show the Watch List.

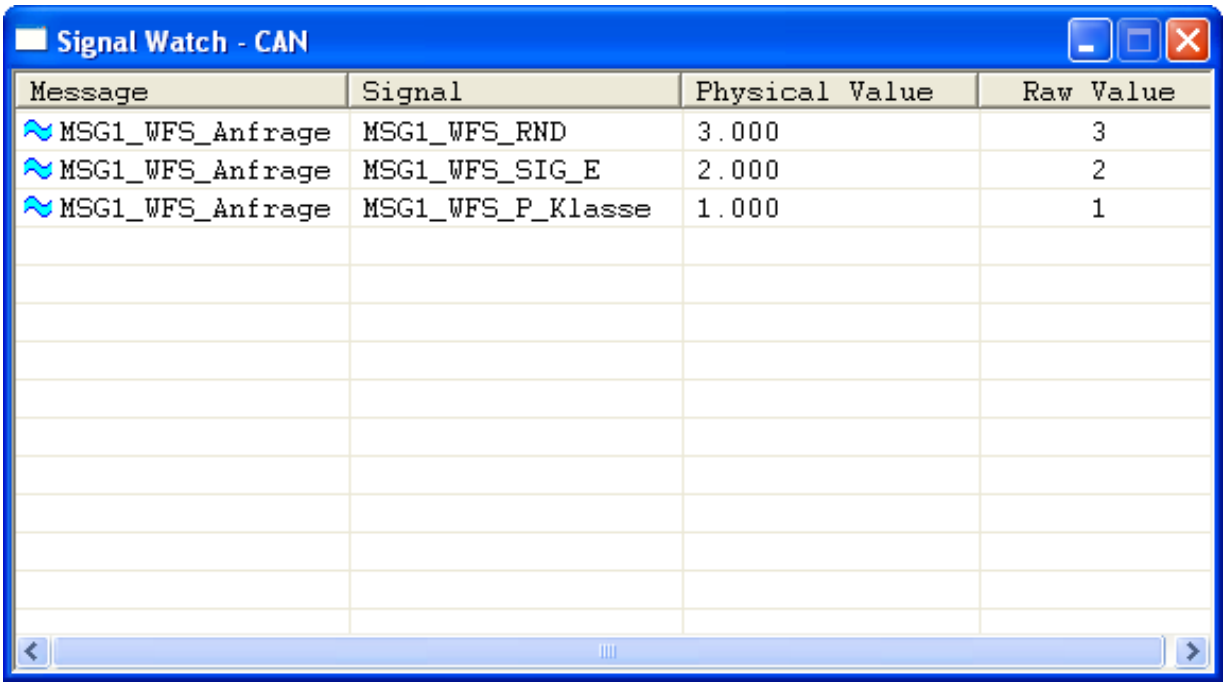


- Select a message and select associated signal from the Signal list. Select Add to move the selected signal in to Watch List. Multiple signals can be added by multiple selection and selecting Add button. All signals belonging to a message can be added in to the watch list be selecting Add All button.
- Double clicking the signal name in Signal List will add the signal in to the Watch List.
- Signal from the Watch List can be deleted by selecting the entry and by selecting Delete button. Multiple signals can be deleted by multiple selection.
- Signal Watch List can be cleared by selecting Delete All button.
- Changes will be saved and applied on selection of Ok. Cancel will ignore the changes.
- The Signal Watch List will be saved in the configuration file and will be reloaded during the load of that configuration file.

Note: To get details of a signal right click the signal and select Signal Details menu item. This will show signal details like start bit, length, type etc. in a dialog.

Show Signal Watch Window

To popup signal watch window, select the toolbar button explained in the previous section and select Show. This will show the Signal Watch Window.



After receiving a message BUSMASTER will update the signal watch window if the signals of received message are included in the signal watch list. The signal watch list will show Raw and Physical value of the signal with the Unit along with Message and Signal name.

Close signal watch window

User can directly close the window by clicking on Close [X] button.

OR

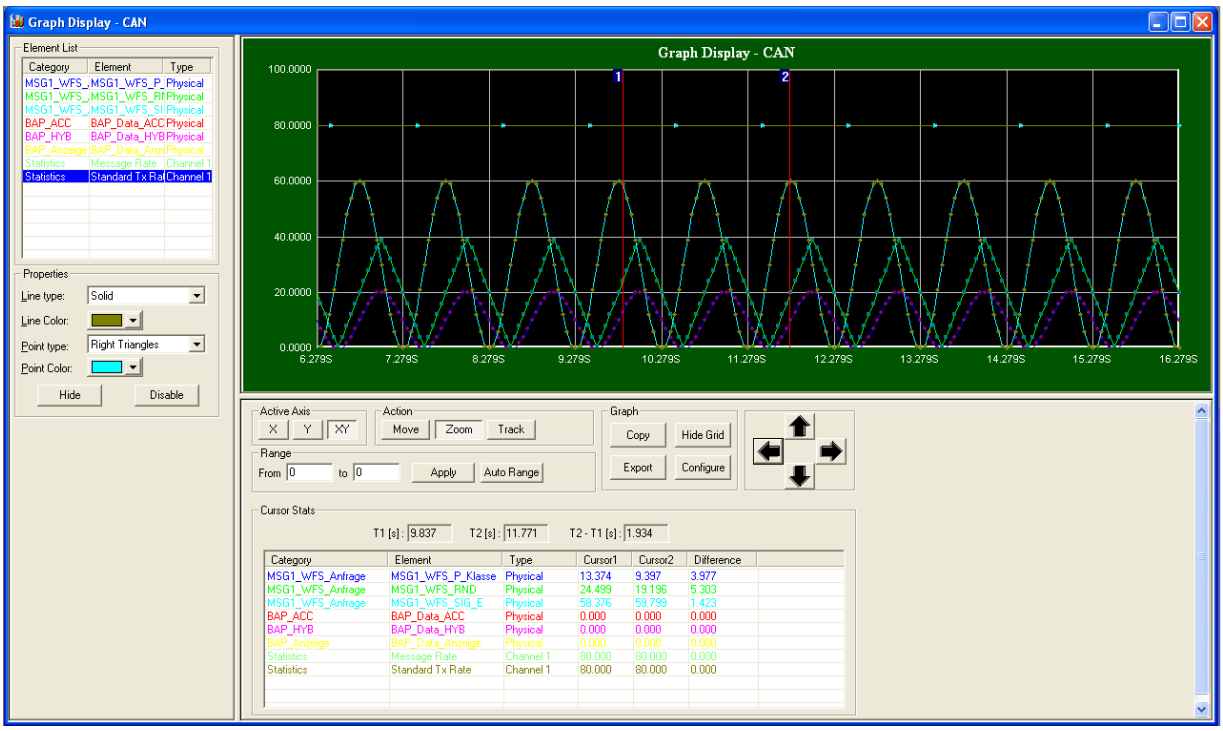
1. Click on the drop-down button associated with the tool bar button shown above. This will pop-up a menu.
2. Click on Close menu option to close the signal watch window.

Signal Graph

Graph Support for Signal and Statistics

BUSMASTER Graph supports plotting graph for signal values and statistics parameters. This includes raw and physical values of a signal. Network statistics parameters can be added to plot graph. The number of graphs plotted is limited to 10. Various types of graph are supported by BUSMASTER. This includes types, color and sample points highlight with symbols. For analysis of the plotted graph various graph manipulation options are provided. The graph data can be exported in various formats ranging from image to report.

Starting With Graph



To Start with BUSMASTER graph select **CAN --> Signal Graph --> Activate** menu item. This will show Graph Display with configuration setting option. The left side view will show list of elements added for plotting the graph. Below the element list properties of the selected element will be listed. This includes line type and color, sample point symbol type and color. An element can be hidden from the display and an element can be disabled so that it will not get currently receiving data. To configure element list Configure button is provided. This will show a dialog with database messages and statistics parameters.

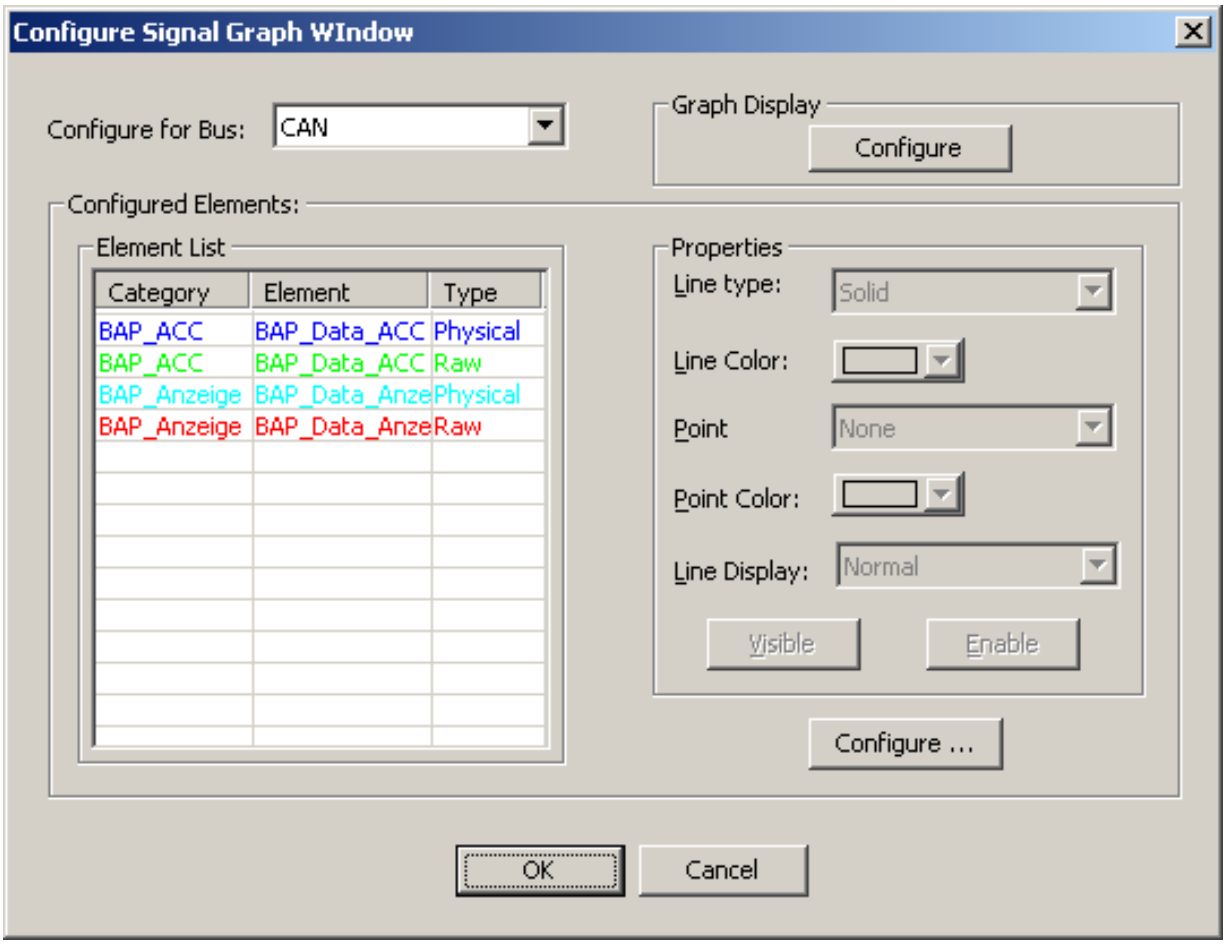
The right side view shows graph window. Below that controls are provided that will manipulate plotted graph. These ranges from basic manipulation of graph like moving, zooming and tracking the value. Advanced features like setting scale values automatically, setting all graph elements one below another and setting manual range. For easy navigation directional navigation keys are provided which will move the graph in the selected direction by one grid position.

Graph control shall be configured in terms of performance and view style. Graph buffer size and update rate can be configured by the user to optimize the performance. Graph window view style shall be fully configured by the user including colors of various graph window components. User shall configure the graph window to his known style like oscilloscope or Excel graph.

Data from graph buffer shall be exported in various formats. This includes exporting data as image, CSV used in excel and detailed HTML report. HTML report shall be printed after creation by BUSMASTER. This report shall be modified by the user after create using any HTML editor externally. This report will include graph elements detail like range, unit, color and min-max values.

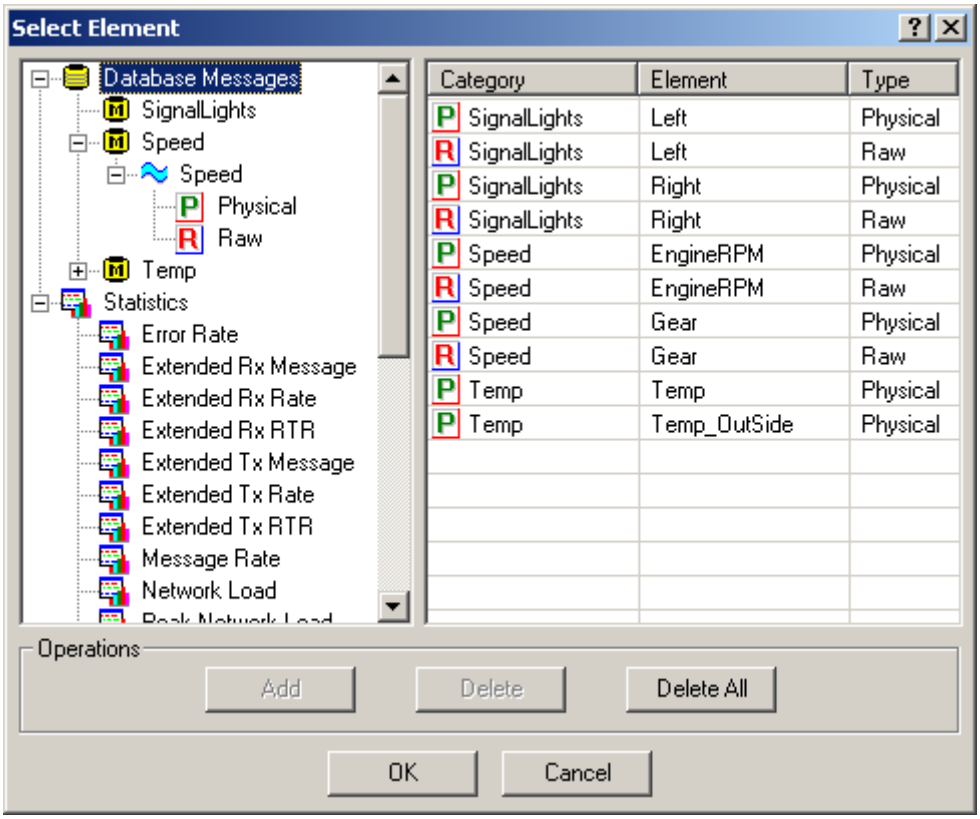
Configuring Graph

To configure graph for a particular bus with graph elements or statistics elements select **CAN --> signal Graph --> Configure** menu item. This will show Configure Signal Graph Window dialog.



Select the bus name from the combo box for which you wish to configure graph elements data.

Click the 'Configure ...' button in the Configured Elements: group box shown in the above dialog. Element Selection dialog will be shown.



This dialog will show list of database message-signals and statistics parameters. Each signal will have physical and raw value entries. As soon as a signal value (physical or raw or both) is added in to the list that will be removed from the tree. To add an item, select the item (Physical or Raw value of signal or statistics parameters only) from tree and select Add button. This will add the item in to element list and will remove the item from tree.

Note:

- To add an item quickly, just double click the item.
- After an element addition element color and sample point type are automatically assigned.
- Only 10 elements are allowed to add. If elements count exceeds 10 the Add button will be disabled and double clicking the item will show error message.

To delete an item from the element list, select the item from the element list right side and select Delete button. This will remove the selected item from element list and will put the deleted item in to the tree at the appropriate place.

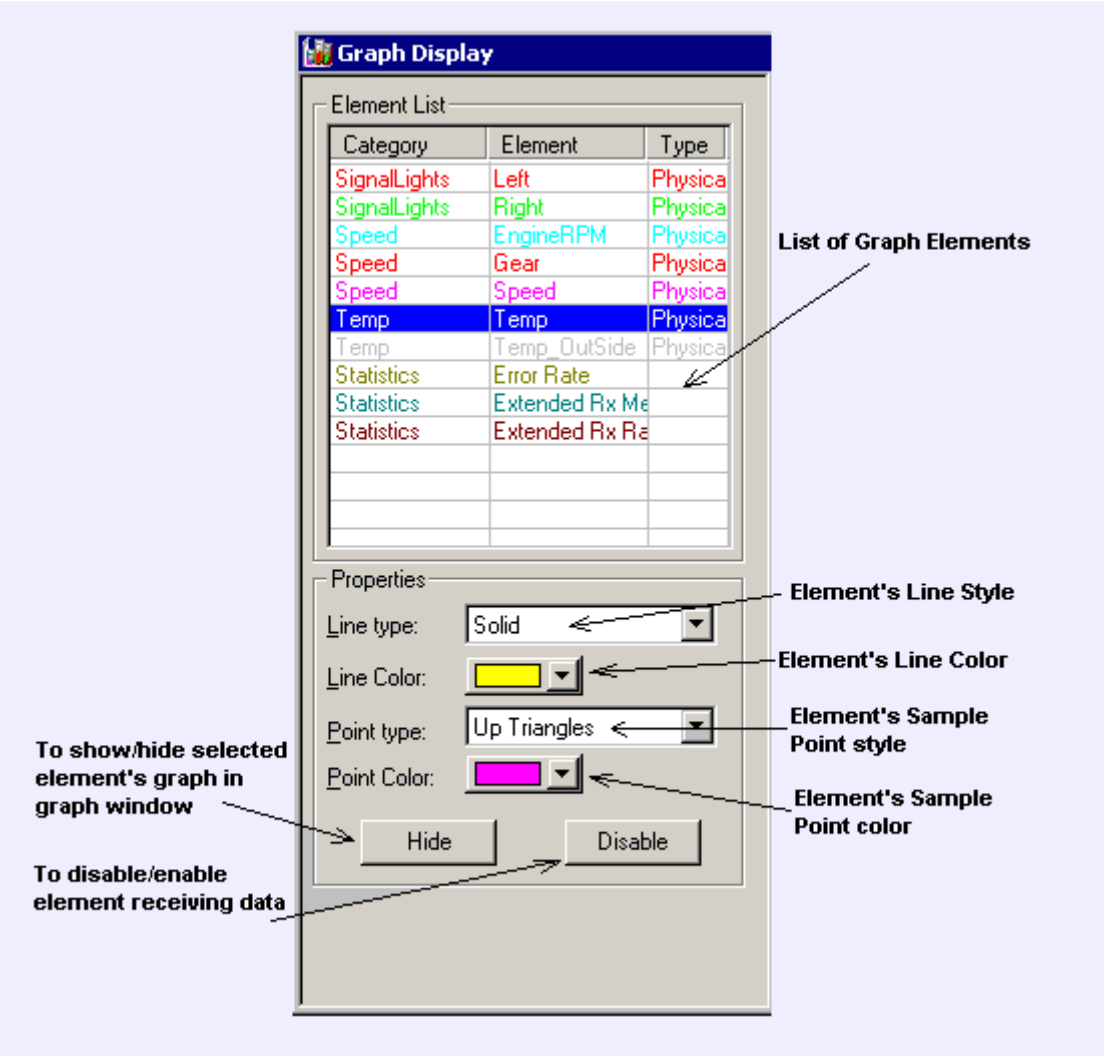
To delete all item from the element list select Delete All button. This will cleat element list and will refresh tree to include all database messages and statistics parameters.

Note:

- To view details of a database signal just double click the item from element list. This will popup signal details dialog with signal definition.
- Selecting OK will save changes and will close element selection dialog .
- To undo changes done in element selection dialog just select Cancel button. This will ignore all changes done by the user.

Graph Element List

The graph element list will be shown in left side view of graph window. This will show element name, category and value type. For a database signal this will show signal name, message name and value type. For statistics parameters this will show parameter name. Each element will be displayed in the color of that graph element. Selecting an element will update the element properties below the list.



Select a list item to see the element details and to modify the details. The selected item will be highlighted in the graph using bold solid line. Various line styles and point styles are supported by BUSMASTER. Sample points symbols will be drawn only if the tool is in disconnected state. When to tool is connected, the graph will go to tailored mode or run mode where cosmetic components of the graph will not be drawn.

Line Type

BUSMASTER graph supports various types of lines ranging for different line styles to different line types. The following is the list of supported line types.

- Solid - Graph with solid line
- Dashed - Graph with Dashed lines
- Dotted - Graph with Dotted lines
- Dash-Dot - Graph with Dashed and Dotted lines
- Dash - Dot - Dotted - Graph with Dash followed by a Dot followed by a Dotted line.

Line Color

Color of the graph line. User can select standard colors from the palette or user can define own color from the RGB and illumination space.

Point Type

Type of the sample point element. User can select sample point symbols to highlight the points at which graph got samples. This will be disabled by selecting point type as NONE. BUSMASTER supports following symbol types.

- None (To Disable Sample point Symbols)
- Dots
- Rectangles
- Diamonds
- Asterics
- Down Triangles
- Up Triangles
- Left Triangles
- Right Triangles

Point Color

Color of the sample point symbol. User can select standard colors from the palette or user can define own color from the RGB and illumination space.

Show/Hide

This is to show or hide a graph from graph window. The hidden graphs will not be plotted in graph window. But a hidden graph will receive samples if the tool is connected. User can be able to view the hidden graph at any point of time. This is to hide the graph from drawing.

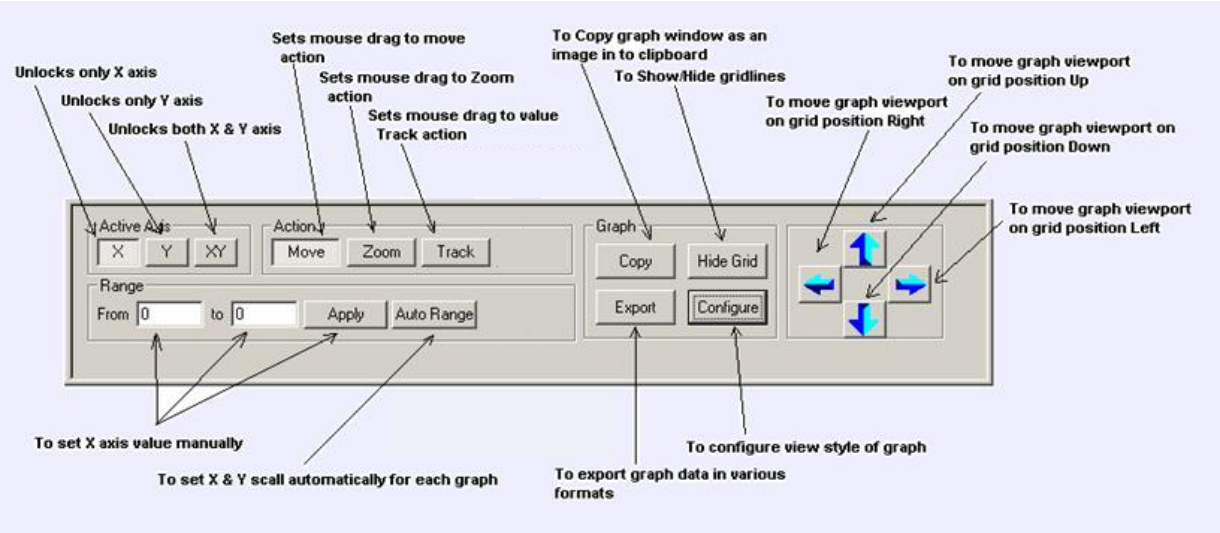
Enable/Disable

This is to enable or disable a graph element from receiving sample values. If a graph is disabled it will not receive any update for message/signals or statistics parameters. This is to avoid a graph getting samples from message/ signals or statistics parameters. If the tool is connected and a graph element is disabled, it will not get latest values. If it is enabled again it will start getting latest values. Changing the enable property will reflect only if the tool is connected.

Note:

- Due to highlight, the line style modification will not be visible during selection. This will be visible if the selection moves to other element
- Disable is a run time option. This will be considered only if the tool is connected and message activity is on.

Graph Manipulation Controls



Active Axis

This unlocks mouse move only in the enabled axis. If X axis is selected only X axis value of mouse movement will be taken in to account. The behavior is same for Y axis too. If XY is selected then axis local will be removed and both X and Y will be considered for the action specified in the Action frame.

Action

This setting will be taken during mouse drag. Action MOVE will move the graph while dragging the mouse in graph window. If ZOOM is selected the mouse drag will result in zooming the graph. TRACK will show the value at mouse cursor point in terms of selected element Y axis and X time axis values. The actions zoom and move are combined with active axis. If action is MOVE and active axis is X then mouse drag will move the graph only in X Axis. Similarly if action is ZOOM and active axis is X then mouse drag will zoom the graph only in X Axis (time scale zooming). Track will work independent of active axis. It will show both X and Y value of mouse point. This will freeze the graph from mouse drag actions and XY scale will remain same.

Range

To set time axis value for all graphs this range option is given. This has inputs from and to. This will be the time axis min and max values. Valid time scale value shall be set by selecting the button Apply. Apply will validate time entered time scale value and will set the X axis time value. Decimal values could be entered to see the graph more closely.

E.g.

- From 1 To 10 (Sec)
- From 2.23 To 2.24 (Sec)

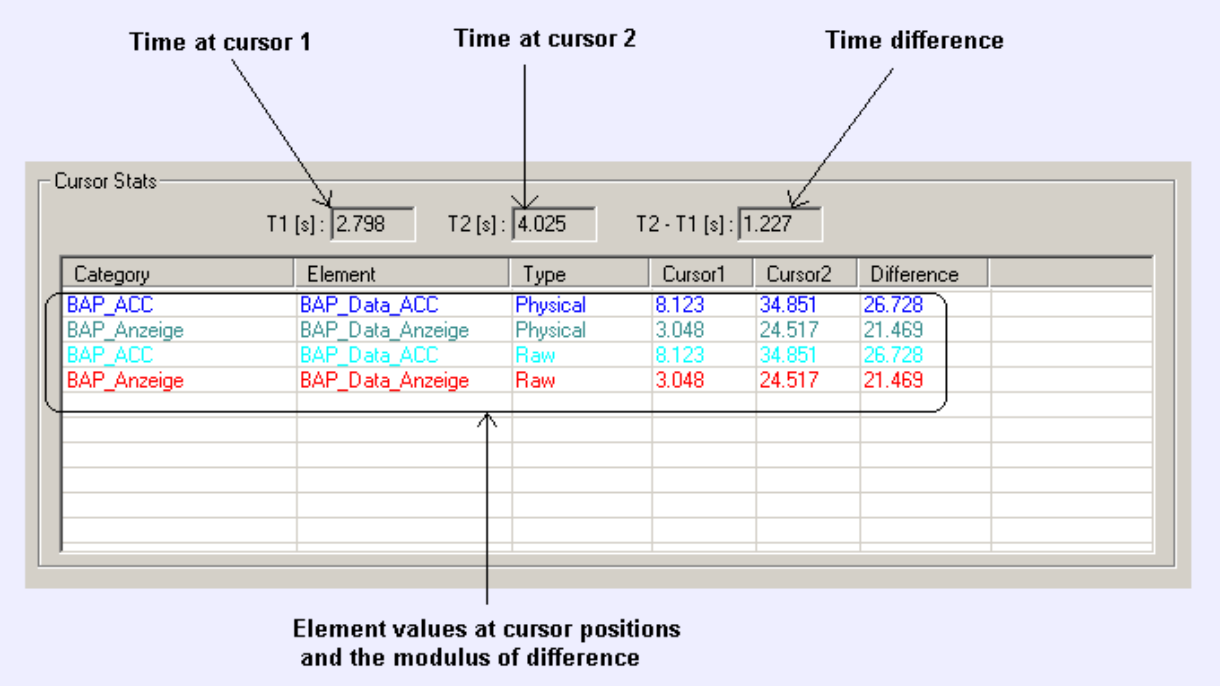
Auto Range

To set optimal values for time axis and Y scale for all graphs auto range option is given. This will find the min and max time value to set optimal X Axis value. Each graph will set its own Y axis value such that the graph will occupy whole graph window. All graphs will overlap each other as each graph is utilizing whole graph window. This mode will be useful to find the overlapping between the signal values or to compare value of various signals and statistics parameters.

Auto Fit

To set optimal values for time axis and Y scale will set to a value such that each graph will be displayed one by one. This will be useful to find all graphs with out any overlap. All graph elements will occupy portion of graph window so that its element value will not merge with other graph element. The whole graph area will be shared across all graph elements.

Cursors for Signal Tracking



Description

Cursors for Signal tracking is an offline feature available for viewing the element values at different time values.

Cursors can be activated by left mouse double clicks on the graph. When the two cursors are activated, user can view the time values at respective cursor postions and the element values in the bottom view of the graph as shown in the above figure.

User can deactivate the cursors by right mouse double click on the graph.

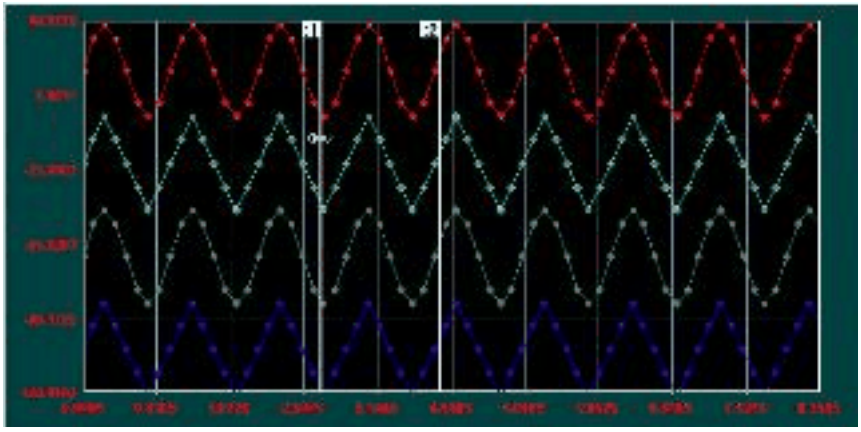
The time values at cursors are shown in a read only edit boxes. The list box shown in the above figure presents the interpolated element values at both the cursor positions and the modulus of difference between both the values.

Track Mode

Track mode is activated by clicking the Track button in Actions group of Graph manipulations controls.

In this mode, user can drag the cursors to new time values. For this user has to position the mouse on the cursor which is to be dragged to a new position. Then keep holding the left mouse and drag the cursor to new position.

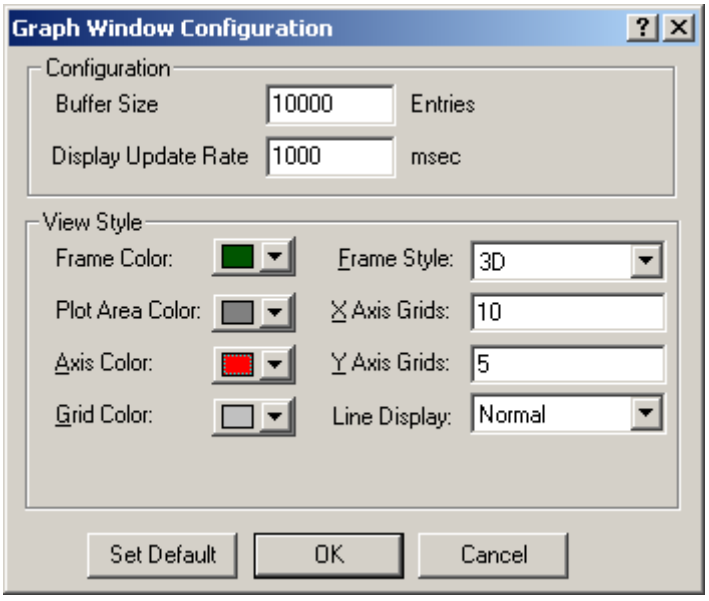
The image below shows the dragging of cursor to new time value.



If the user wants to clear the cursors on the graph at any point of time, right mouse double click will do the job.

Graph Window Configuration

To change look and feel of graph select Configure button from right side view of graph window. This will popup graph configuration dialog. This dialog has various graph view style parameters.



Buffer Size

User can configure graph buffer size in terms of number of entries in the graph. Buffer will be created with this size for each graph elements in the graph. If the graph has two message signals and two statistics signals and the buffer size is 10000 entries, each element can hold 10000 entries and individual buffers will be created to hold 10000 samples. Once the buffer will become full old data will be removed to make room for latest data. For optimal performance of the tool keep this buffer size minimum or with the default value. The supported value for this parameter is between 1000 - 50000 entries.

Display Update Rate

This is the cyclic time delay after which the display will be updated. This refresh timer delay will be set to this value. The default value is 1000 msec or one second. The supported value for this parameter is between 1000 - 20000 millisecond.

Frame Color

This is the color of the Frame. Frame is the rectangle area that covers the graph plotting area. This parameter depends on the frame style also. This color will be considered only for frame styles FLAT and SCOPE. Selecting this button will popup a dialog where standard colors will be displayed. There will be an option to give custom RGB values also.

Plot Area Color

This is the color of graph elements plotting area. This forms the background of the graph area.

Axis Color

This is the color of axis rectangle. Axis rectangle is visible only if the frame style is flat. Other wise this rectangle will be hidden by 3D border of the frame.

Grid Color

This is the color of grid lines. This change will be visible only if grid lines are visible.

Frame Style

Three types of frame styles are supported. FLAT, 3D and FRAME. In flat style axis rectangle will cover graph plotting area. This is a flat rectangle. In 3D style a 3D rectangle will cover graph plotting area. Axis rectangle will be in 3D format. In FRAME style a gradient picture will be used to cover plotting area.

Grid Lines

This will configure number of grid lines displayed on X and Y axis. Supported range is 2 - 10. The grid line starts from left to right in case of X axis. The last grid line will merge with right side boundary. For Y axis grid lines will start from bottom to top. The last Y axis grid will merge with top boundary of the graph.

Line Display

This will configure line display style of grid lines displayed on X and Y axis. Currently three styles of display are supported for graph drawing. They Normal , Step Mode XY (Graph will be advanced in X axis first and then in Y Axis.) and Step Mode YX (Graph will be advanced in Y axis first and then in X Axis.).

Set Default

This will set all parameters to default values. View style parameters will be set to default color and style. Buffer size will be set to 10000 entries and display update rate will be set to 1000 msec.

Note:

- All graph window configuration parameters are saved in BUSMASTER configuration file. While loading a configuration file all are restored.

Graph Export

BUSMASTER graph shall be exported in several types. These are Comma Separated Format or CSV, detailed HTML report and as a bitmap picture. In CSV export graph element details are exported with corresponding time values.

To make extensive test report HTML format will be handy. This will generate a report in HTML format with graph and elements details. The same shall be printed directly from BUSMASTER if Print option is enabled.

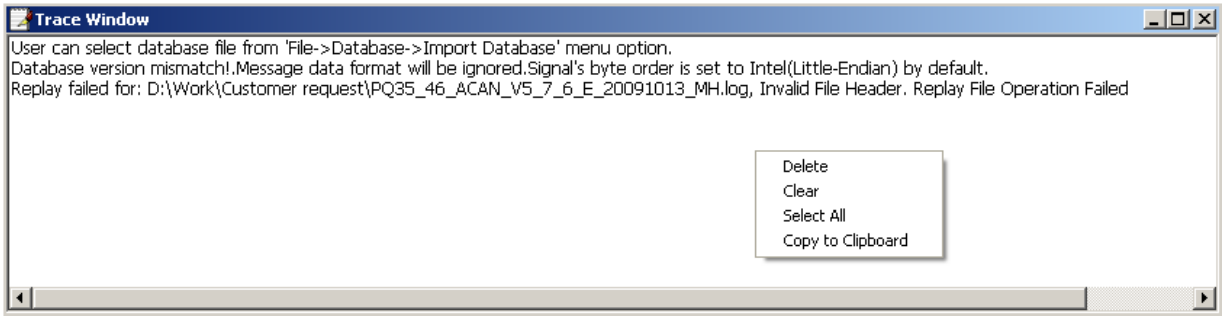
To save the graph window details as image, image export option is given. This will save the graph windows snapshot in to the specified bitmap file.

Note:

- CSV export will export only the data that is currently in element buffer of the graph.
- HTML report will take the snapshot of the graph window. This will not modify either time range or y axis appearence. User has freedom to set any time range and Y axis range. This should be done before exporting the report.
- To optimise printing, select light plot area color. This will make background of the graph lighter and elements can be easily identified.
- **Note:** Select Landscape as page format to fit whole report in one page.

Trace Window

Trace window gives details about the result of the latest operation. Result can be information, warning or error. Below picture shows some text displayed in the trace window. This window basically contains a multiple selection list box where user can select, clear, delete the entries. It is possible to copy the text into clipboard also.


Trace Window
User can select database file from 'File->Database->Import Database' menu option.
Database version mismatch!.Message data format will be ignored.Signal's byte order is set to Intel(Little-Endian) by default.
Replay failed for: D:\Work\Customer request\PQ35_46_ACAN_V5_7_6_E_20091013_MH.log, Invalid File Header. Replay File Operation Failed
Delete
Clear
Select All
Copy to Clipboard

To display trace window Select the menu **Window --> Trace Window**.

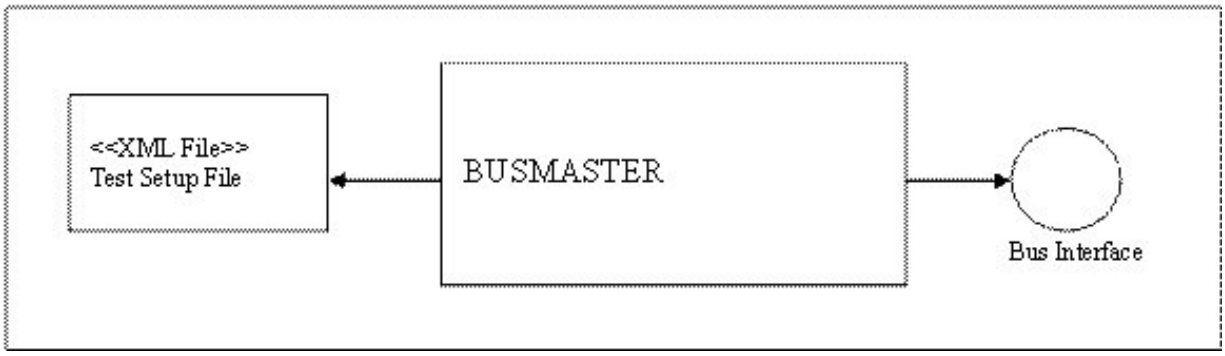
Test Automation

Introduction to Test Automation

Test Automation is a process of optimizing the effort in testing where the user only needs to define the test cases (rather than writing codes in Node programming). The test cases may be taken directly as input parameters for the execution of a testing session carried out by Test Automation module of BUSMASTER. This means user can expend more time for writing proper test cases rather than implementation issues of the same.

To be noted - this is neither a substitute nor a variant of node programming. In the former the actions are predetermined; it is only the parameter set (both in terms of signal value and time axis) that varies, whereas in the later the node behavior / logic are programmed. So the Test Automation is an extension of the tool to simplify the process of carrying out tests of a genre and generating the report.

A schematic diagram of Test Automation scenario is presented below:



Test Automation in BUSMASTER can be divided into three Modules:

- Test Setup File
- Test Setup Editor
- Test Executor

Test Setup File

Description

A test setup is a XML file which contains the instruction set of the various test cases. The contents test setup file can be divided as follows:

- Test setup := <Header> + <Test case list>
- Test case list := {test case 1, test case 2, ..., test case N}, where N >= 1
- Test case := {test step 1, test step 2, ..., test step N}, N >= 2
- Test step := transmission / wait / replay / verification operation

Explanation

- Test Setup: Test setup file contains two sections Header and Test Case List
- Header: Header contains the basic information regarding to the test setup file, like versions, report file path, database file path, ECU name, tester information etc. User has to provide the information. Some values are optional and some are compulsory. Database path is a compulsory value. Check the table below for the required and optional fields.
- Test Case List: Test Case List contains a collection of test cases. User has to create the test cases.
- Test case: A test case is the collection of test steps such as send, wait, replay, verify.
- Send: This is a collection of send_messages. This test step instructs to send the specified messages.
- Send Message: This provides the details of message to be send. User has to initialize the messages and its signals. The default value assumed to the signals is 0. The message value my be given in engineering value mode or in raw value mode.
- Wait: Wait node instruct to wait certain period of time, expressed in terms of milliseconds.
- Replay: Replay node instructs to replay BUSMASTER log file.
- Verify: This is a collection of verify_messages. This test step instructs to verify the specified messages (both Rx and Tx).
- Verify Response: This test step verifies the specified message responses (Rx Messages) with in specified time. So this step requires a time interval.
- Verify Message: This provides the details of message to be verify. The user needs to formulate the validation condition. In the formula current signal value shall be denoted by 'x' following the algebraic notation. The presently supported logical operators are the eight: ==, >, <, >=, <=,!= , ||, and &&. By combining them suitably the following validation operations may be carried out:
  - Range of values; e.g., (x <= 10) && (x >= 50)
  - Set of discrete values; e.g., (x == 10) || (x == 20) || (x == 50)
  - Formulation of any other validation procedure.

Here is a sample test file: *SampleTestSetupFile.xml*.

The table below contains a concise description of each of the section details and error handling procedure in case of absence of any information.

Section (tag)	Description	Assumed value if absent	Error condition if absent
Test setup (`testsetup`)	The root node. Accompanied by its title (title) and version information (version)	-	Fatal
Database file (`database`)	Database file		Fatal
Version (`version`)	Version information of the test setup	1.0	No error
Module Name (`module name`)	Module focused on for the testing	-	No error
Engineer's name	Test engineer's name	-	No error
Engineer's role	And role / designation	-	No error
Report file path (`path`)	Particular of the report file to be generated.	Current working directory with the name same as the test setup.	Error
Report file format (`format`)	Format of the report file. Can be one of TXT and HTM	TXT	Warning
Report file time mode (`timemode`)	Time mode. Can be one of SYS (system), REL (relative) and ABS (absolute)	SYS	Warning
Bus type (`bustype`)	Bus type. At present can be only CAN	CAN	Fatal
Test case list (`list_of_test_cases`)	Collection of test cases.	Nil	Error. There must be at least one entry.
Test case (`testcase`)	Collection of test steps. A test case contains identifier, title and exception handler. The last one instructs if in case of failure to continue or exit.	Nil	Error. There must be at least an entry.
Test case title (`title`)	Test case title	-	No error
Test case exception handler (`exp_handler`)	Instructs if in case of failure the testing process exists or continues. Can be one of continue or exit	continue	Warning

Section (tag)	Description	Assumed value if absent	Error condition if absent
Transmission (`send`)	Collection of the messages to be transmitted.	-	No error
Transmittion message details (`send_message`)	Details of the message list to be transmitted.	Nil	Warning
Send message id (`identifier`)	Identifier of the message.	-	Error. The test case shall be dropped.
Send message unit (`unit`)	Unit type of the signals. Can be either raw (raw) or engineering (eng)	Engineering value	Warning
Signal (`signal`)	Details the signal with its name (name) and value.	-	Error. The test case shall be dropped.
Verification (`verify`)	Verification instruction set. Contains a collection of verification messages.	Nil	Error. A test case must have a validation routine. Test case shall be dropped.
Failure classification (`failure`)	For a verification procedure – how to classify validation failure. Can be one of warning, error, fatal	Error	Warning.
Verify message details (`verify_message`)	Details of the message list to be verified / validated.	Nil	Error. The test case shall be dropped.
Verify message signal detail (`signal`)	Details of a signal under a verify message node. The attribute required is the signal's name (name). The node value shall be a string with formulation of the condition. This shall follow the syntax mentioned in the table below.	Nil	Error. The test case shall be dropped.

So, As explained above the test setup file has to write in XML format. So user has to know the syntax of XML and the test set up file. But To simplify this process BUSMASTER provides an editor called Test Setup Editor.

Test Setup Editor

Test setup Editor is useful to create and edit a test setup file. Here is the list of different services rendered by the editor.

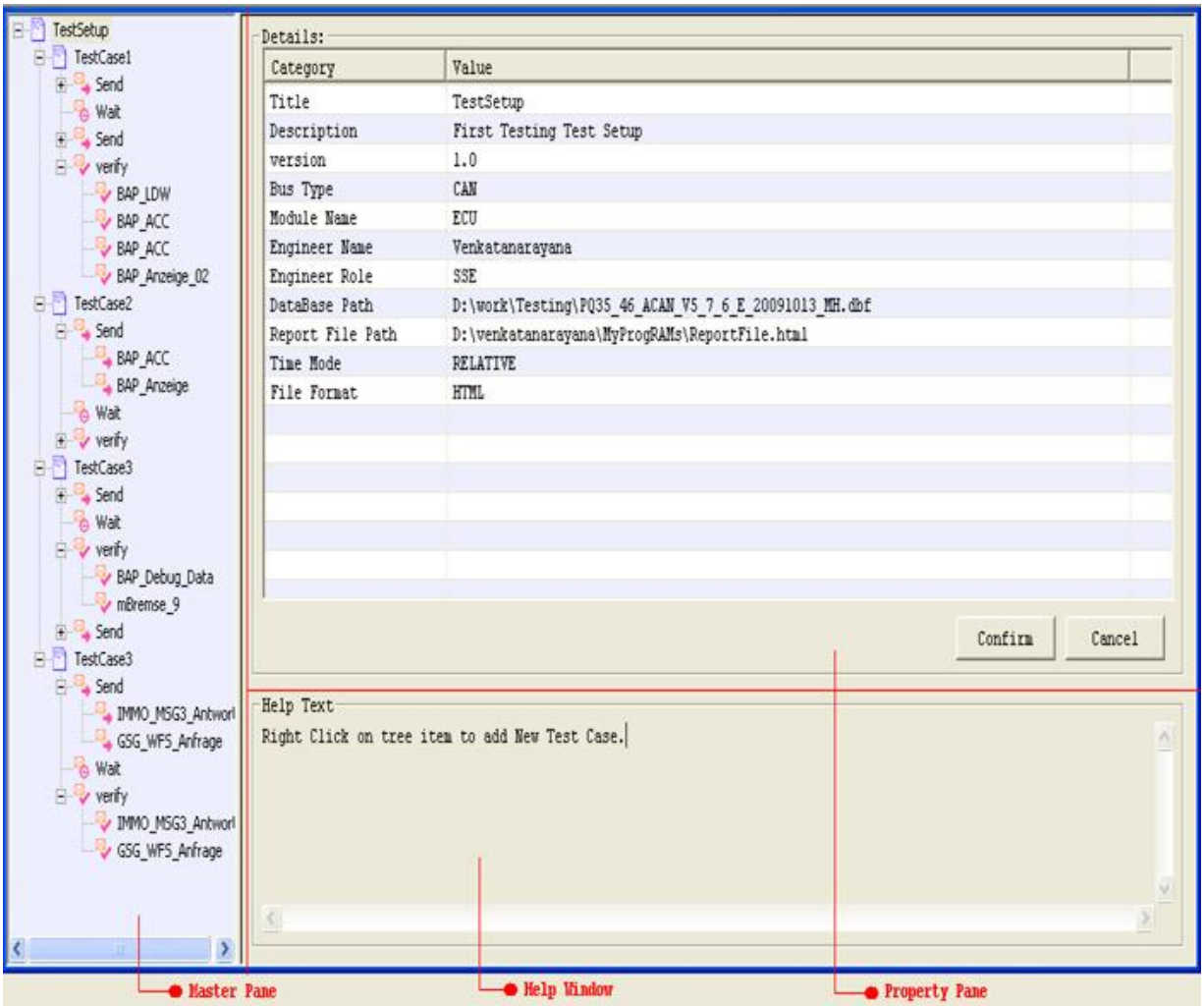
Features provided by test setup editor

- Create a new test setup file
- Save a test setup file
- Load an existing test setup file
- Create, edit and update a test case
- Define a test case by adding its sub nodes like send, wait, verify, and replay
- Reposition a test case
- Delete a test case
- Create, edit, and update a new test case node
- Adding, deleting a send message to send node
- Initialization of a send message node
- Adding and deleting a verify message node to verify node
- Create a validation procedure for each signal in the verify message
- Create a wait node
- Repositioning a test case sub node
- Copy, cut, paste operation on Test case and its sub nodes
- Validate the test setup file

Invoking Test setup editor

To open the test setup editor, In BUSMASTER click on menu Item **CAN --> Test Automation --> Editor**.

The first look of Automation Editor will be as shown in the figure below. To make things easier the BUSMASTER Menu will be replaced with the Test Automation Editor.



Master Pane: The master pane or right pane can be used to add or update the test cases.

Property Pane: The user can use the Property pane or Left pane to update the details of a Test case or its sub nodes.

- It contains a table with two columns **Category** and **Value**. The value in **Category** field can not be changed and it's like a question. To update the value in any row of **Value** column double click on the cell item. An edit box or a list control will appear according to the context.
- Also the pane contains two buttons **Confirm** and **Cancel**. The **Confirm** button can be used to save the current changes made to the node. Note that these changes will not be saved to file. For saving into a file select **File** > **Save** (see following section for menus). The **Cancel** button Will cancel all the changes made and display the previously saved data.

Help Window: The help window will provide help on every node. Click on any item on right pane to get the details of that node.

Test Setup Editor Menu

The functionalities, provided by the Test Setup editor, are grouped under the Test setup editor Menu. This Menu will be shown in BUSMASTER when the editor is in active mode or user clicked on the Editor.

File : The **File** menu contains all most all the functionalities provided by the editor. It contains the following sub menus.

- **File** > **New** : Use to create a new test setup file. **Ctrl + N** is the keyboard short cut.
- **File** > **Open** : Use to Open an existing test setup file. **Ctrl + O** is the keyboard short cut.
- **File** > **Close** : Closes the current file.
- **File** > **Save** : Saves the current changes to the file. **Ctrl + S** is the keyboard short cut.
- **File** > **SaveAs** : Saves the current data into another file.
- **File** > **Validate** : Validates the current file according to the table under Test Setup File.
- **File** > **Exit** : Closes the editor.

Edit : The **Edit** menu will provide the operations such as cut, copy, and paste.

- **Edit** > **Copy** : Any item on the right pane can be copied using this menu. **Ctrl + C** is the keyboard short cut.
- **Edit** > **Cut** : Using this menu any item on the right pane can be deleted by copying it. **Ctrl + X** is the keyboard short cut.
- **Edit** > **Paste** : The copied item can be inserted under any parent item by selecting the parent item and this menu. For example the copied `send_message` can be inserted in any send node of any test case.

Display : The **Display** menu is used to customize the GUI.

Help : The **Help** menu provide the version details about the editor and also opens this help file.

Using Editor

- Creating a new test setup file: Select **File** > **New** menu. A file browser will be displayed. Select a required folder and enter the file name. Click on **OK**. The editor will create a new test setup file and a new test setup with some initial values.
- Updating test setup: Initially the name of test setup will be **<New Test SetUp>** displayed in right pane. Click on this item (test setup node) and update its details such as test setup name, description, version, bus type, module name, engineer info, report file path and database in left pane. The database path is very important.
- Creating a test case: Right click on the test setup node on right pane. A pop up menu will appear click on **New Test Case**. A new test case with Initial name **Untitled TestCase** will be created.
- Updating a test case: Click on required test case node. The left pane will show the details of test case and you can edit the details and click **Confirm** button.
- Deleting a test case: Right click on required test case node. A pop up menu will displayed. Click on **Delete** item. The test case will be deleted from the test setup.
- Adding a new test sequence: Right click on required test case node. A pop up menu will be displayed. Click on **New** menu and select the required node.
- Updating a test sequence: Click on any test sequence item. And edit its detail in left pane and click on **Confirm** button.

- Deleting a test sequence: Right click on any test sequence item. A pop up menu will appear. Click on **Delete** item to delete the node.
- Adding a message: To add the messages in send, verify etc nodes, Click on the required send node. Double click on the **[Add message]** cell on right side. If a database is added in the Test setup node, A list box containing the messages will appear. Select a message to add in list. After adding a new row with **[Add Message]** will be added in list box in order to add another message.
- Delete a message: To delete a message double click on that message. Select **[Delete Message]** in list in order to delete the message.

Test Suite Executor

Test suite executor is used to execute one or more test setup files sequentially. The result of execution will be logged into the result file specified in test setup file. The collection of test setup files are called test suite. Here is the list of different services rendered by the editor.

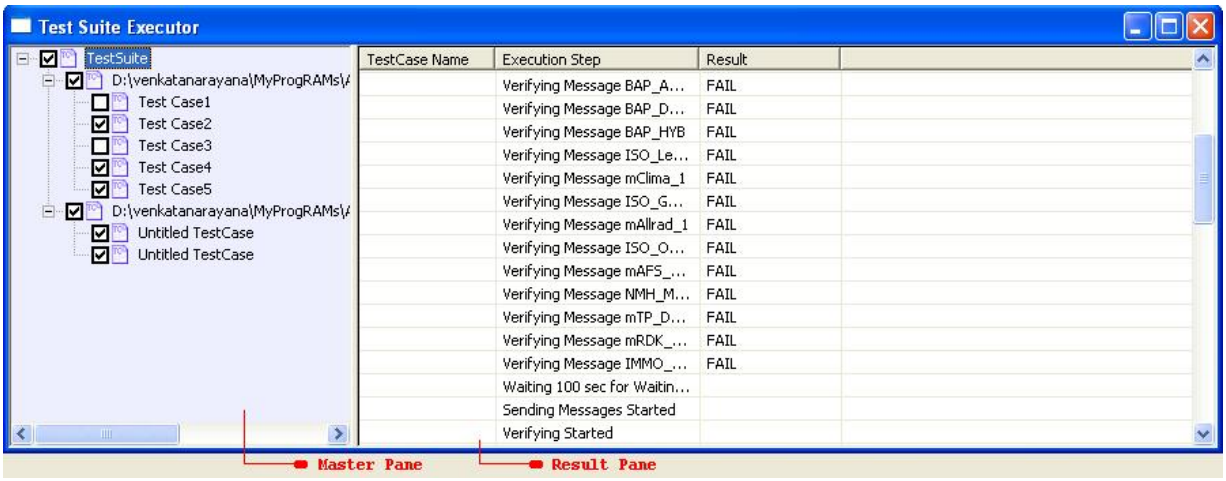
Features provided by test suite Executor

- Adding a test setup files
- Delete a test setup file from the execution
- Select/Deselect a test setup file for execution
- Select/Deselect a test case for execution
- Execute the test suite

Invoking Test suite Executor

To open the test suite editor, in BUSMASTER click on menu Item **CAN --> Test Automation --> Executor**.

The first look of test suite is shown in the following figure:



Master pane: Using this pane we can add test setup files and select and deselect a test case. All the functionalities described in the following section can be performed using this pane.

Result pane: The **Result pane** will display the current execution status of the test suite.

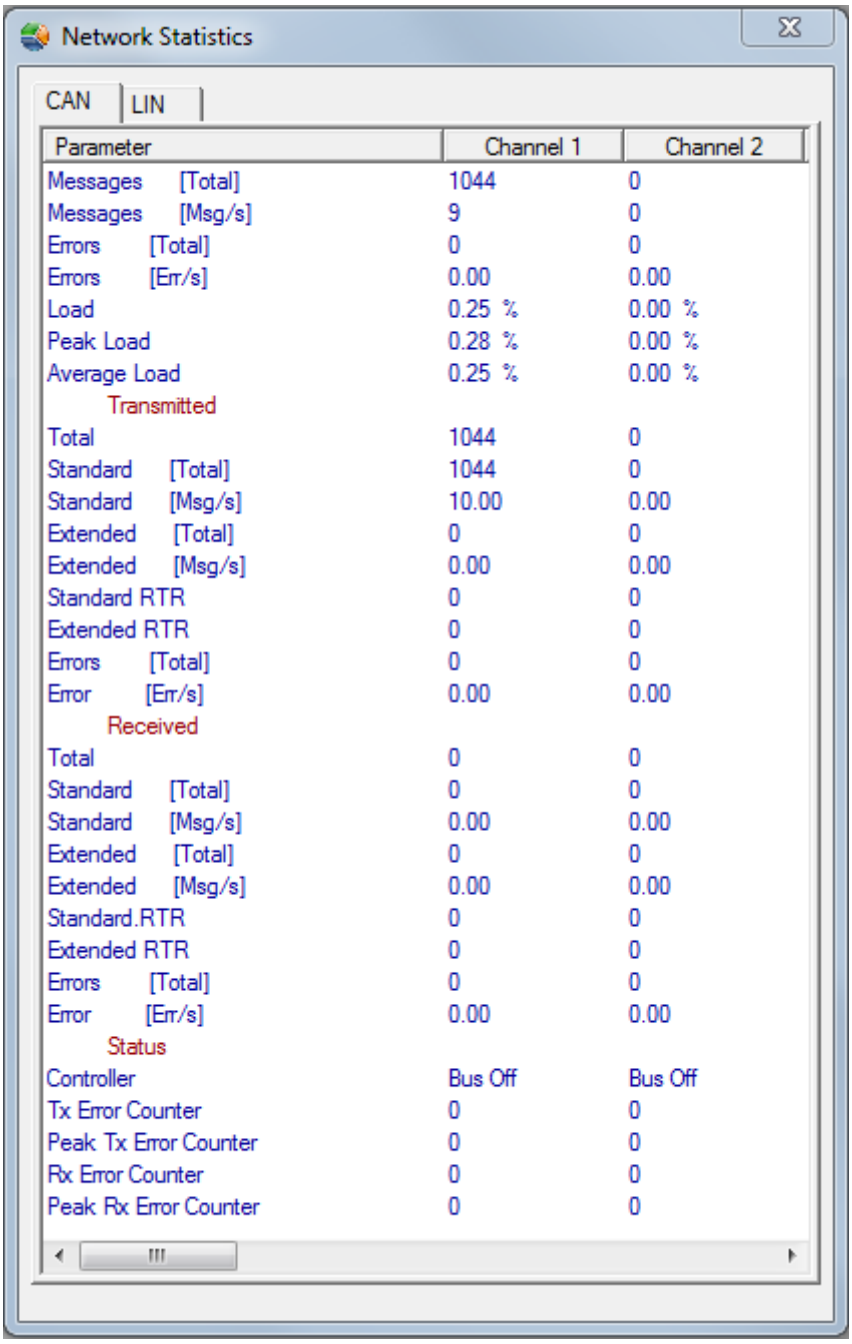
Using Executor

- Naming a test suite: Double click on the top most tree node (test suite node) on master pane. A edit box will appear, give a suitable name and press **enter**.
- Adding a test Suite: Right click on the test suite node. A pop up menu will displayed. Click on **Add** Menu. A file browser will appear where you can select a test setup file. If the file is correct one the executor will add it in test suite and displays all its test cases.
- Select/Deselect a test suite: To select or deselect test setup for execution click on the check box located near the test setup file.
- Delete a test setup file: Right click on the required test setup file and select **Delete** in the pop up menu.

- Select/Deselect a test case: Click on the check box of particular test case to enable or disable it for execution. Note that if the test setup is deselected from the execution then all its test cases are nor executed.
- Execute test suite: Right click on the test suite node and select **Execute** in the pop up menu. Each selected test case is executed and the summary will be displayed in **Result** view.

Network Statistics

Network statistics dialog gives details about the messages transmitted and received on the bus. This information includes the number of Standard, Extended, RTR and Error messages transmitted and received by BUSMASTER and current rate of these parameters. This is updated once in a second. Message rate per second and Network load in terms of Bus traffic is also presented. The peak network load will show the peak traffic during that session. This information can be used to find bus utilisation. Statistics information will be cleared during connect and during controller reset.



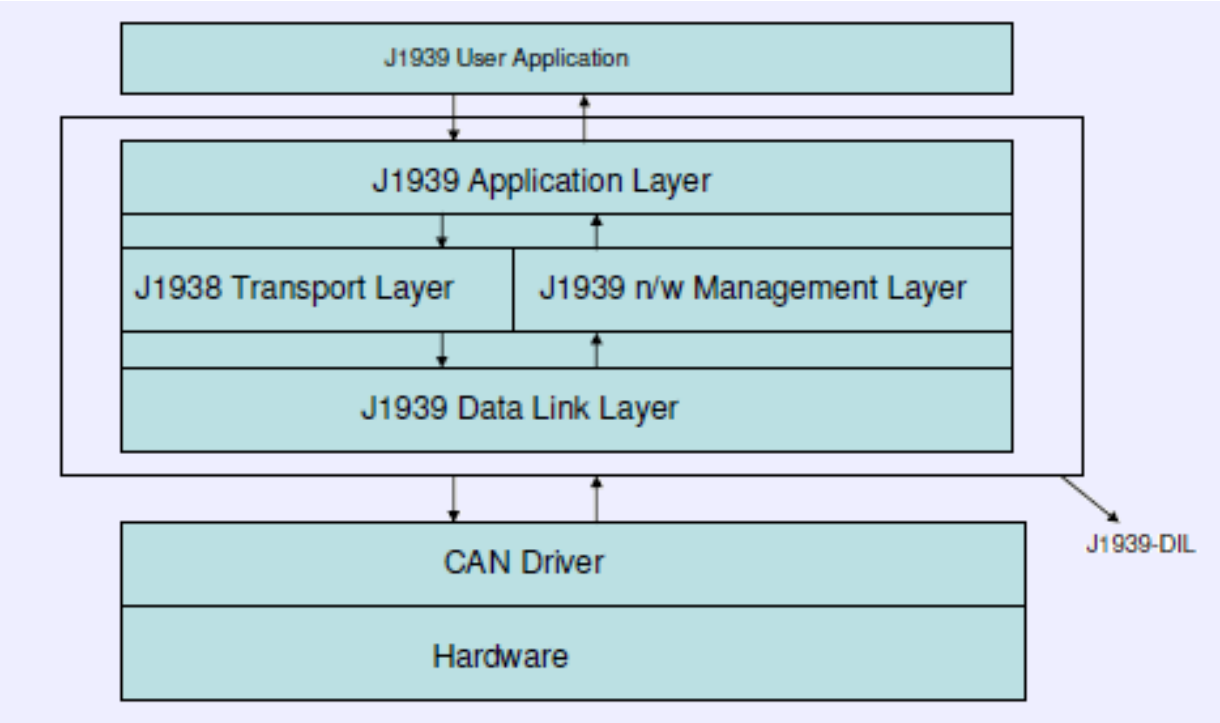
To invoke Network Statistics Dialog, select the menu **Window --> Network Statistics**.

J1939

Introduction

J1939 is a CAN-based layer 7 protocol mainly used in Truck and Bus control and communications. The typical properties of J1939 are:

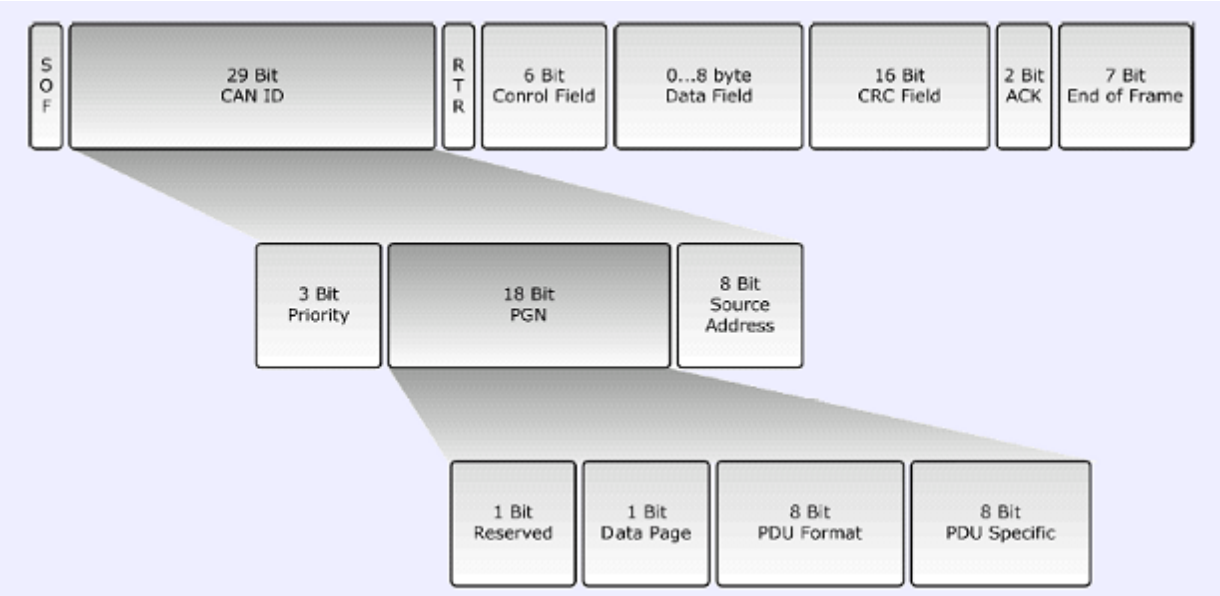
- 29 bit extended CAN identifier.
- Point-to-point and broadcast communication.
- Transmission up to 1785 bytes.



J1939 Protocol Stack

Parameter Group Number (PGN):

PGN identifies the Parameter Group (PG). PGs point to information of parameter assignments within 8 byte CAN data field, repetition rate and priority. The structure of PGN allows a total of 8672 different Parameter Groups per page – 2 pages are available.



Parameter Group Number

Transport protocol function

Transport protocol functions are mainly used for transmission and reception of multi-packet messages which can extend upto 1785 bytes. Function involves packaging into sequence of 8 byte size messages during transmission, re-assemble of such data at the receiver side.

1. Multi-packet broadcast

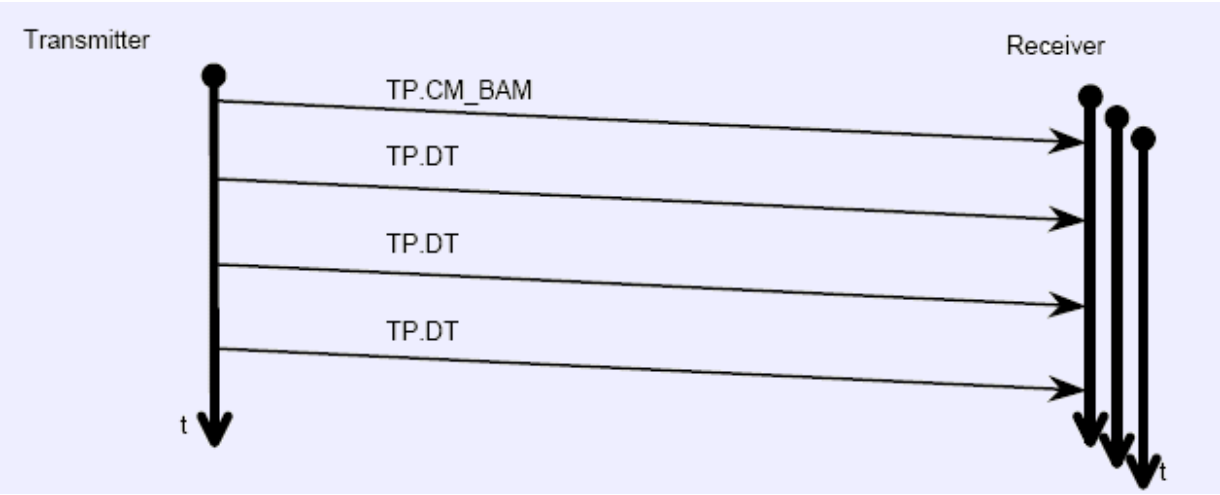
A broadcast message is broadcasted to all nodes in the network. Sender node must first send a Broadcast Announce Message (BAM) followed by sequence of 8 byte data. Receiving nodes can prepare for reception if interested.

BAM message contains following information.

1. PGN to be sent

2. Size of multi-packet message

3. Number of packages



Multi-packet broadcast data transfer

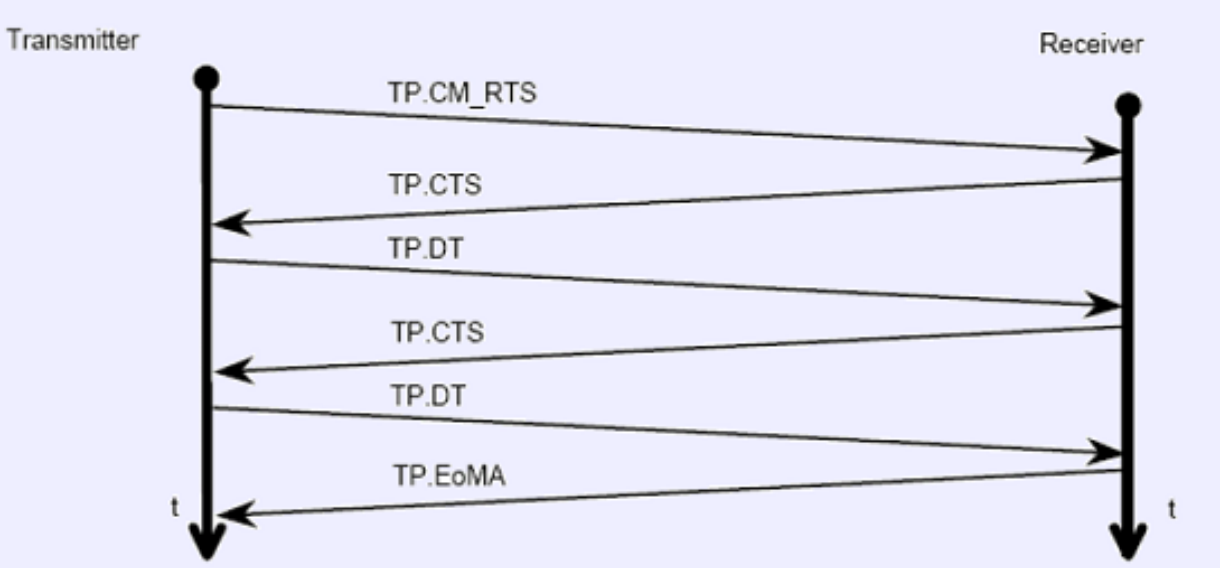
2. Multi-packet peer-to-peer

For destination specific data transmission, communication needs to be established hence subject to flow control. Transport protocol function is applied in three steps.

1. Connection Initialization - The sender of a message transmits a Request to Send message. The receiving node responds with either a Clear to Send message or a Connection abort message incase it decides not to establish connection.

2. Data Transfer - Sender transmits data after receiving Clear to Send message.

3. Connection Closure - The receiver of the message , upon reception sends End of Message ACK message.



Multi-packet peer-to-peer data transfer

Network management

Each ECU in a J1939 network must hold at least one NAME and claim one 8 bit address for identification purposes.

1. ECU NAME - 64 bit identifier includes an indication of the ECU's main function performed at the ECU's address.

J1939 NAME Fields

2. ECU Address - 8-bit ECU address defines the source or destination for messages.

Address claiming procedure

The address claim feature considers two possible scenarios

1. Sending an address claimed message (ACL) - At the network startup, an ECU will cliam an address and send Address Claimed message. All ECUs receiving the address claim will record and verify the newly claimed address with their internal address table. In case of an address conflict, the ECU with the lowest NAME will succeed.

2. Request for Address Claimed message - An ECU Requests ACL message from all nodes in the network and claims available address.

BUSMASTER.J1939

Initialisation

Prerequisite of employing the J1939 functionalities is getting hold of J1939 interface, and this is the sole purpose of this function. This will query for the available J1939 interface. Once this is available, the associated menu item and button will be disabled. The query operation involves DIL.J1939 interface initialisation, a J1939 client registration and finally the J1939 logger interface query and initialisation. Outcome of the query operation can be seen on the Trace window.

Configure Logging

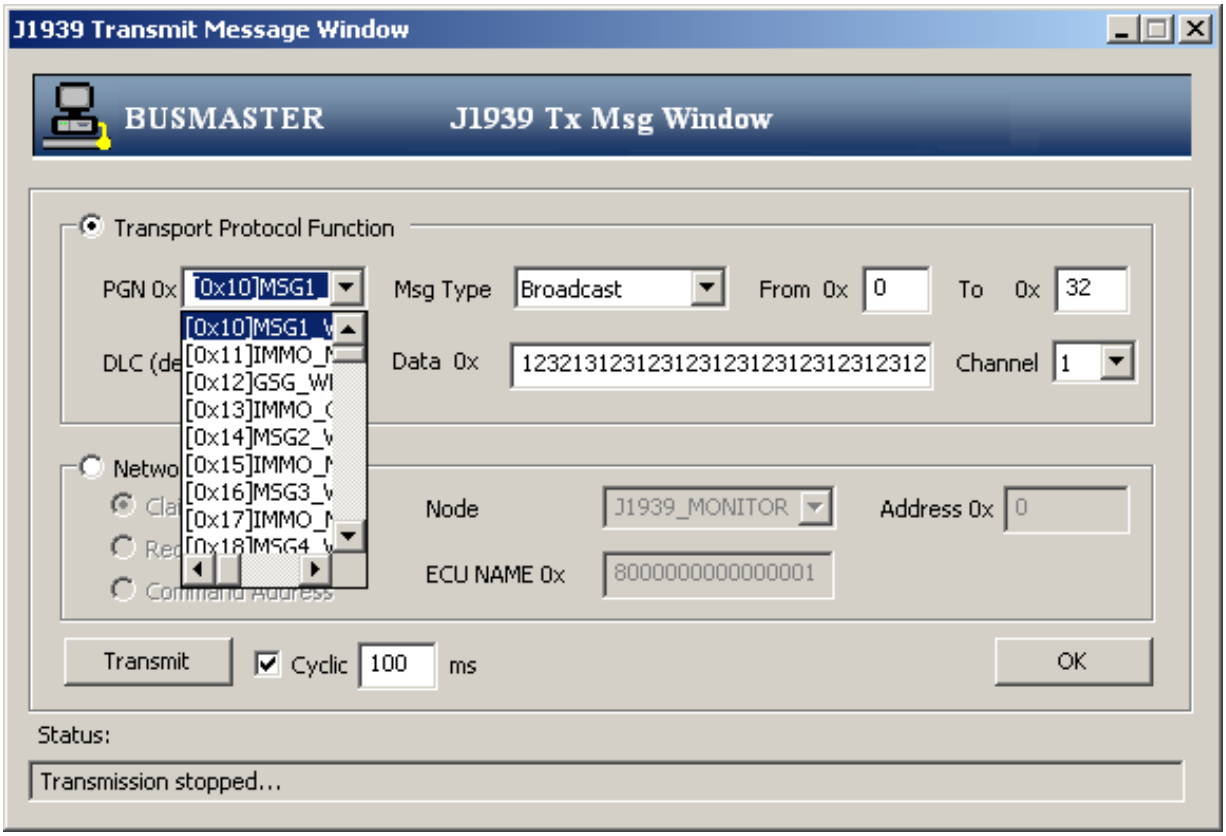
This invokes the logging configuration dialog box whose layout and the configuration procedure is exactly same as that of CAN. Only difference is that for J1939 a message is identified not by CAN identifier, but by its PGN number.

Start Network

This function connects the application to the J1939 network. Both the associated menu item and toolbar icon are toggling in nature and hence shuttle between "Go Online" and "Go Offline" modes.

Transmit Message

This brings in the J1939 transmit message window in which the presently transmittable message can be configured and sent in both monoshot and cylcic mode.



J1939 Transmit Message Window

Logging

By selecting the associated menu item or clicking on the toolbar icon, the user can start the logging process. This has the characteristics of a toggle switch and hence using the same, ongoing logging process can be stopped too.

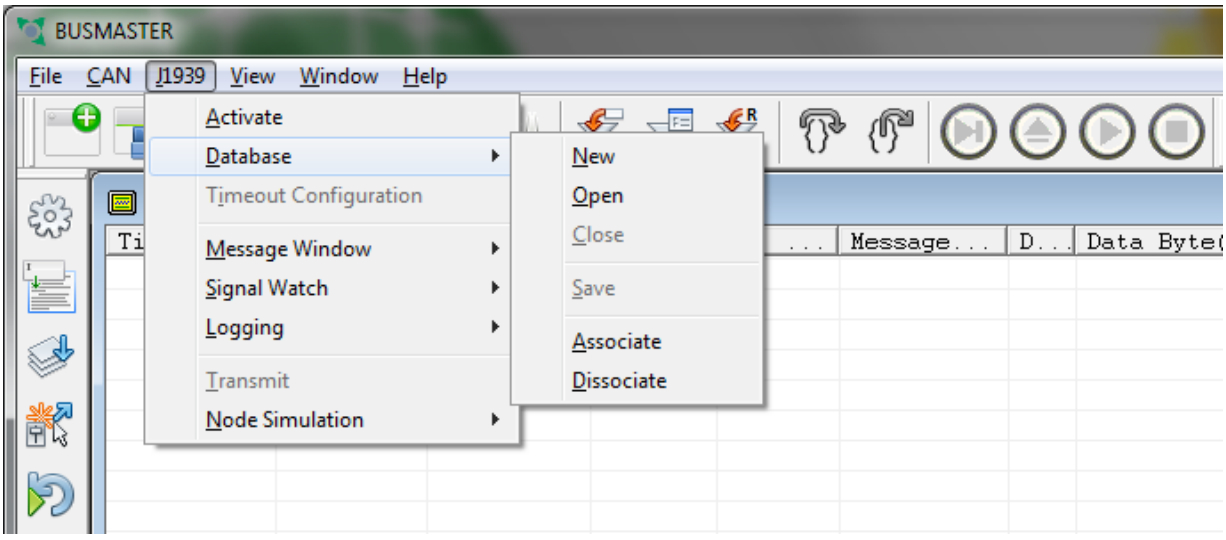
```
***<Time><Channel><CAN ID><PGN><Type> <Src><Dest><Priority><Tx/Rx><DLC><DataBytes>***
25:24:14:6112 1 18eeff00 00EE00 ACL        00   FF   006 Tx 8 01 00 00 00 00 00 00 80
25:24:14:6124 1 18eeff00 00EE00 ACL        00   FF   006 Rx 8 01 00 00 00 00 00 00 80
22:16:26:5893 2 18eeff00 00EE00 ACL        00   FF   006 Rx 8 01 00 00 00 00 00 00 80
22:16:26:5905 2 18eeff00 00EE00 ACL        00   FF   006 Tx 8 01 00 00 00 00 00 00 80
22:16:30:2136 2 1ceefffe 00EE00 ACL        FE   FF   007 Rx 8 01 00 00 00 00 00 00 80
25:24:18:2355 1 1ceefffe 00EE00 ACL        FE   FF   007 Tx 8 01 00 00 00 00 00 00 80
22:16:30:2148 2 1ceefffe 00EE00 ACL        FE   FF   007 Tx 8 01 00 00 00 00 00 00 80
25:24:18:2367 1 1ceefffe 00EE00 ACL        FE   FF   007 Rx 8 01 00 00 00 00 00 00 80
25:24:19:2432 1 1ceaffe 00EA00 RQST_ACL    FE   FF   007 Tx 3 00 EE 00
25:24:19:2440 1 1ceaffe 00EA00 RQST_ACL    FE   FF   007 Rx 3 00 EE 00
22:16:31:2213 2 1ceaffe 00EA00 RQST_ACL    FE   FF   007 Rx 3 00 EE 00
22:16:31:2221 2 1ceaffe 00EA00 RQST_ACL    FE   FF   007 Tx 3 00 EE 00
25:24:20:1554 1 1cecffe 00EC00 BAM         FE   FF   007 Tx 8 20 09 00 02 FF 00 EE 00
22:16:32:1336 2 1cecffe 00EC00 BAM         FE   FF   007 Rx 8 20 09 00 02 FF 00 EE 00
22:16:32:1347 2 1cecffe 00EC00 BAM         FE   FF   007 Tx 8 20 09 00 02 FF 00 EE 00
25:24:20:1565 1 1cecffe 00EC00 BAM         FE   FF   007 Rx 8 20 09 00 02 FF 00 EE 00
22:16:32:2337 2 1cebffe 00EB00 TPDT        FE   FF   007 Rx 8 01 01 00 00 00 00 00 00
22:16:32:2349 2 1cebffe 00EB00 TPDT        FE   FF   007 Tx 8 01 01 00 00 00 00 00 00
25:24:20:2555 1 1cebffe 00EB00 TPDT        FE   FF   007 Tx 8 01 01 00 00 00 00 00 00
25:24:20:2567 1 1cebffe 00EB00 TPDT        FE   FF   007 Rx 8 01 01 00 00 00 00 00 00
22:16:32:3342 2 1cebffe 00EB00 TPDT        FE   FF   007 Rx 8 02 80 FE FF FF FF FF FF
22:16:32:3342 2 1ceefffe 00EE00 BROADCAST  FE   FF   007 Rx 9 01 00 00 00 00 00 00 80 FE
```

J1939 Log File

Message Database

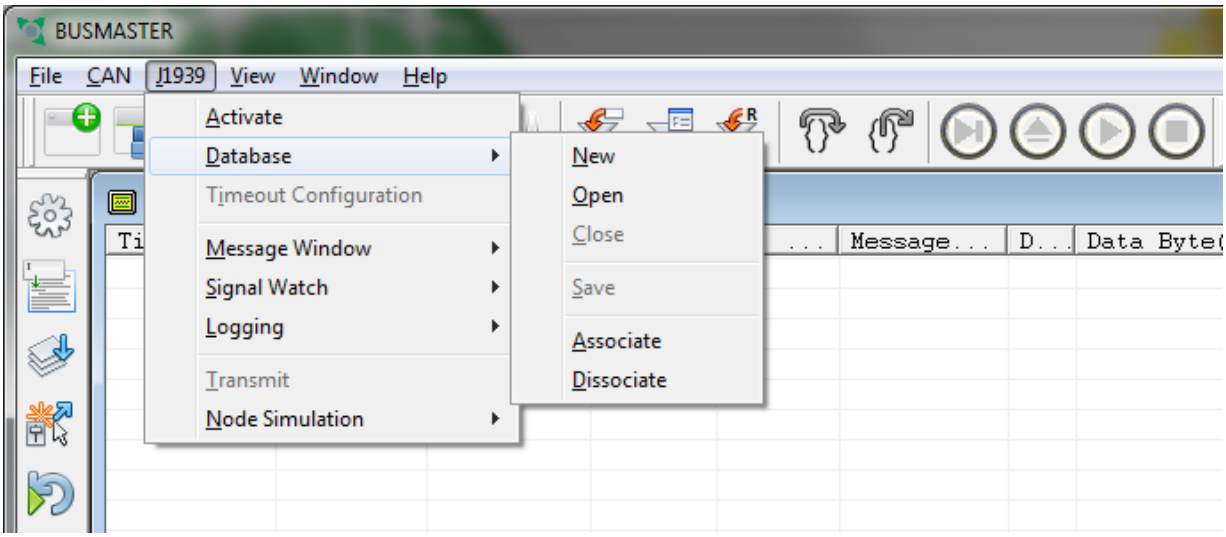
1. Database Editor:

J1939 database editor is similar to CAN database editor. User can define a new message based on its PGN and it can have maximum data size of 1785 bytes.



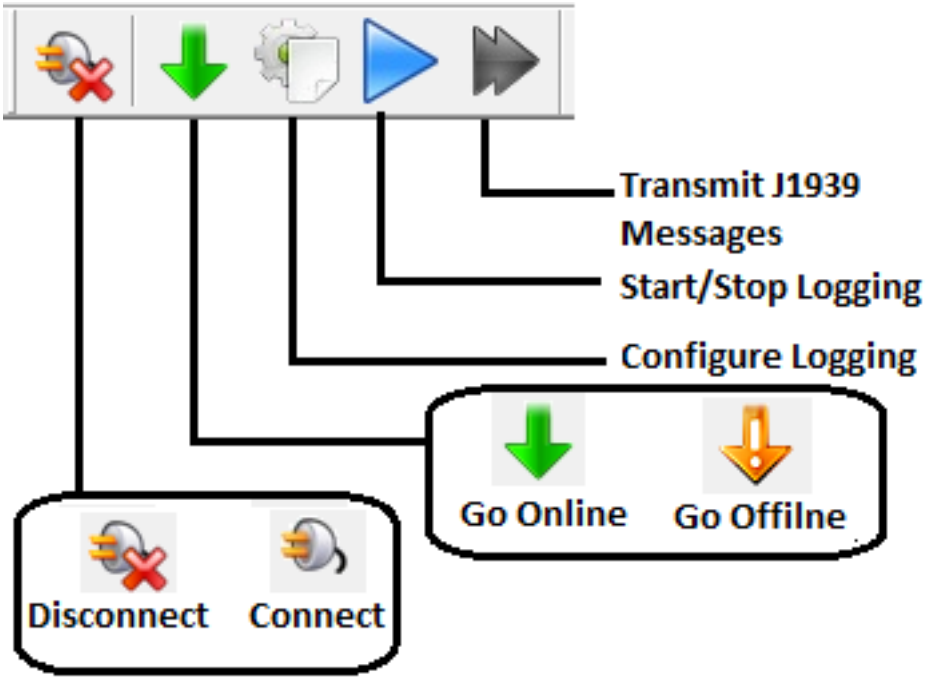
2. Database Function:

User can associate/dissociate J1939 database files.



Toolbar

A separate toolbar is available for J1939 option.

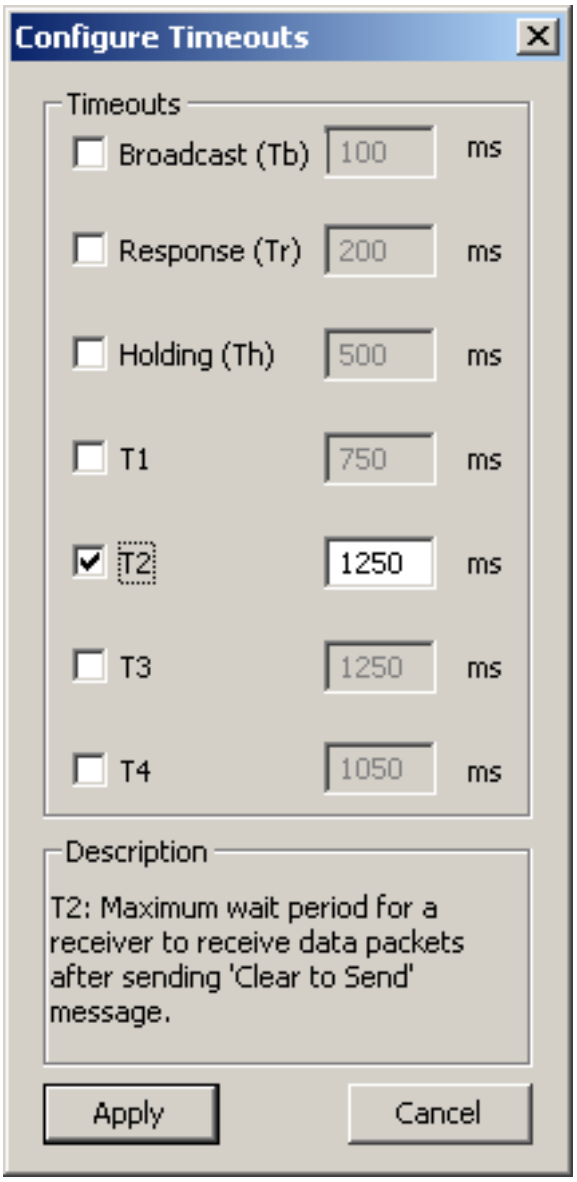


Configure Timeouts

User can configure timeouts which will be considered when flow control messages are being sent or received.

Corresponding dialog box can be invoked by clicking the menu **J1939 --> Timeout Configuration**.

Timeout's description will appear on clicking the corresponding check box.



Tb: Time interval between two packets in broadcast transmission.

Tr: Maximum wait period for a sender to receive a response from the receiver.

Th: Time interval between two 'Clear to Send' message when delaying the data.

T1: Maximum wait period for a receiver when more packets were expected.

T2: Maximum wait period for a receiver to receive data packets after sending 'Clear to Send' message.

T3: Maximum wait period for a sender to receive 'End of Message Acknowledgement' after sending last data packet.

T4: Maximum wait period for a sender to receive another 'Clear to Send' message after receiving one to delay the data.

Signal Watch

J1939 signal watch window is similar to CAN signal watch window. User can add SPNs(Signals) of the PGN defined in database.

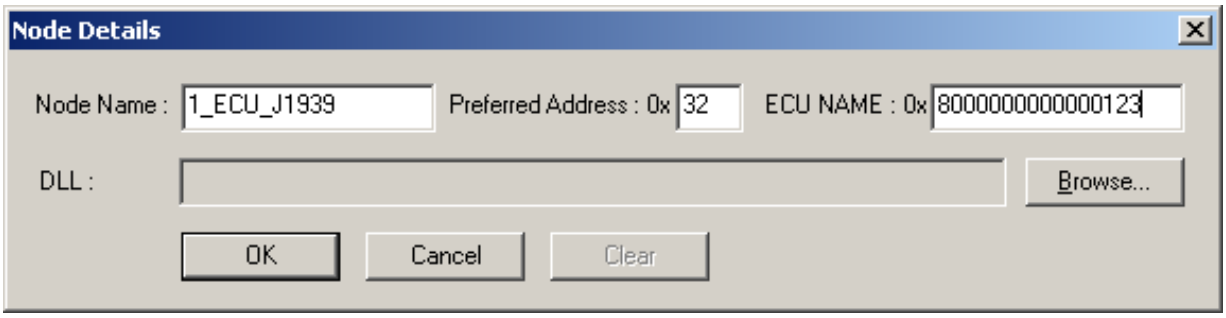
Node Programming

Seperate menu items are available for configuring J1939 node programming. Use '**J1939 --> Node Simulation --> Configure**' menu for configuring nodes and '**J1939 --> Node Simulation --> User Program**' menu for

Building, Loading and Execution of user dll handlers. Most of the features of J1939 node programming remain same as that of CAN. Few differences are listed down.

1. Node Addition : User has to provide following information to create a new node.

a. Node Name b. Preferred Address c. 64 bit ECU name.



2. Function Editor : J1939 Function Editor is similar to CAN Function Editor. In addition to the handlers available in the CAN Function Editor it has **Event Handlers** where user can configure

- **Data confirmation event :** Handler is executed whenever a long(> 8 bytes) message is transmitted.

void OnEvent_DataConf(UINT32 unPGN, BYTE bySrc, BYTE byDest, BOOL bSuccess);

unPGN - PGN of the message transmitted. **bySrc -** Source node. **byDest -** Destination node. **bSuccess -** Result of transmission. (TRUE-success, FALSE-failure)

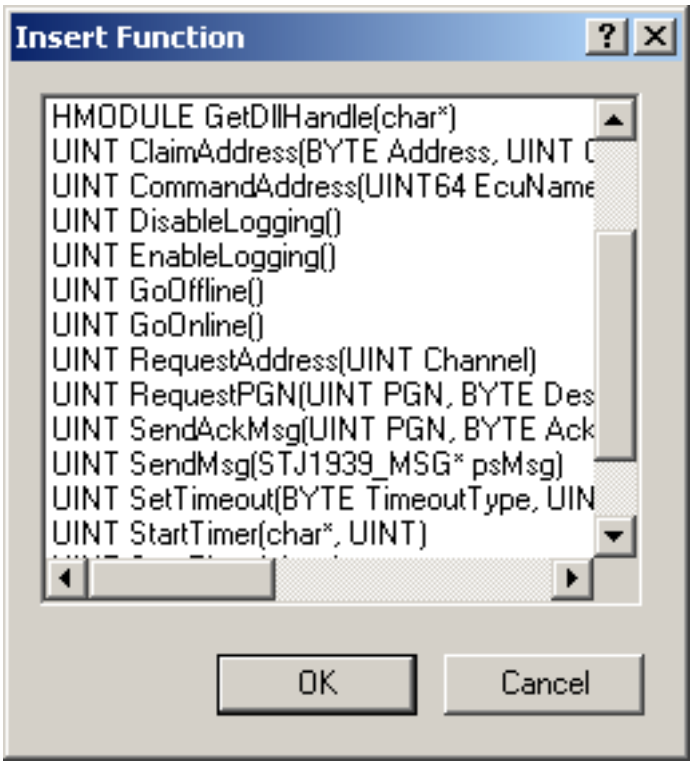
- **Address confirmation event :** Handler is executed whenever a node claims or loses an address.

void OnEvent_AddressClaim(BYTE byAddress) ;

byAddress - New Address claimed by the node. Address lost If the value is 254.

Note: These event handlers are always enabled once added.

3. J1939 API Reference : A new set of API is introduced in-order to perform functions on J1939 bus. Please refer following section API Reference J1939 for further details.



Connect and Disconnect

User can connect/disconnect the tool from the CAN-bus by pressing/releasing a toggle toolbar button shown in the figure below.

The tool can also be connected by selecting **CAN** > **Connect** menu option (available only in disconnected state) or by pressing F2 function key. The same can be disconnected by selecting **CAN** > **Disconnect** menu option (available only in Connected state) or by pressing Esc key. When the tool is in connected state, the menu option will become Disconnect and when the tool is in disconnected state, the menu option will be displayed is Connect.

Transmission and reception of messages can be done only when the tool is in the connected state.

Format Converters

Format Converters:

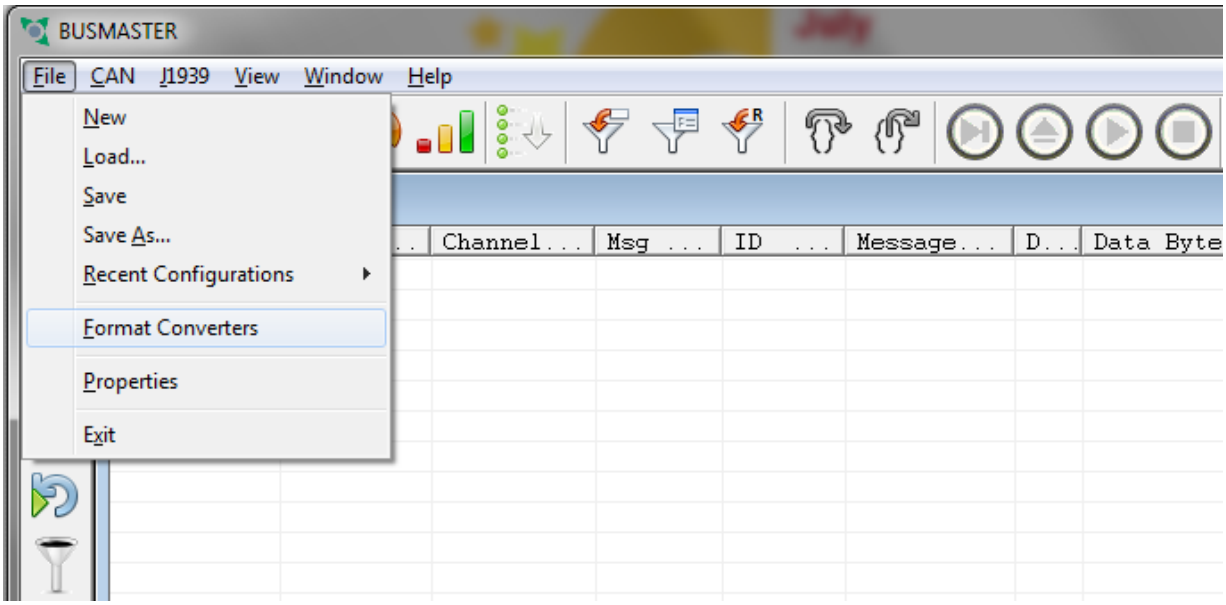
Currently Five external tools are integrated with BUSMASTER

- CAPL To CPP Converter: Converts CAPL (*.can) file into BUSMASTER CPP (*.cpp) file

- DBC To DBF Converter: Converts DBC (*.dbc) file into BUSMASTER database (*.dbf) file
- DBF To DBC Converter: Converts BUSMASTER database (*.dbf) file into DBC (*.dbc) file
- ASC TO LOG Converter: Converts CANoe log file (*.asc) to BUSMASTER log file(*.log)
- LOG To ASC Converter: Converts BUSMASTER log file (*.log) to CANoe Log file (*.log)
- Log To Excel Converter: Exports BUSMASTER log file (*.log) to CSV (Comma Seperated Values) Format
- BLF To LOG Converter: Converts BLF (*.blf) file into BUSMASTER log file (*.log)

Usage:

- To use the Converters select **File --> Format Converters** As Shown in the below figure.



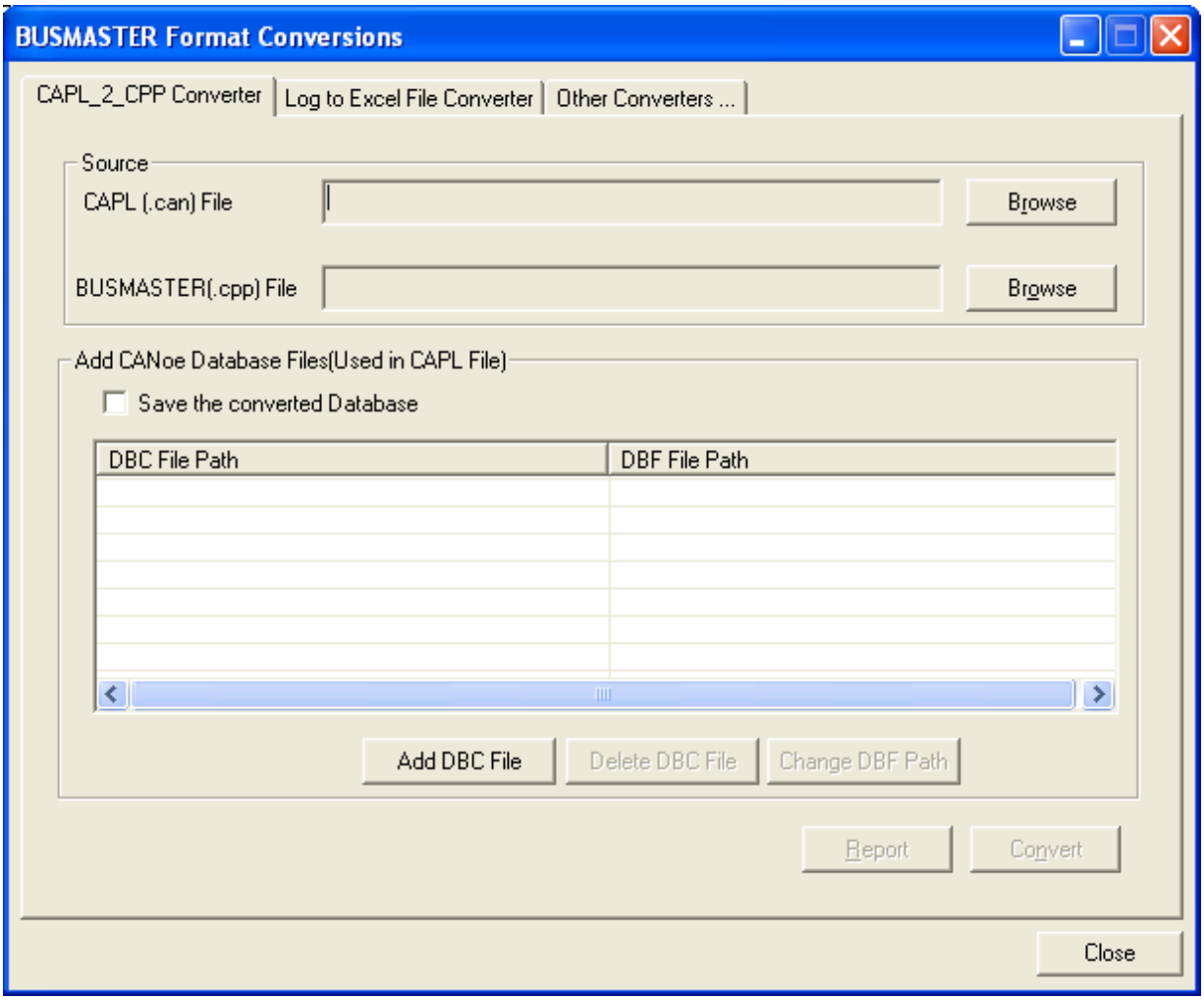
- A window is displayed with 3 tabs in it which caters to various conversions.

CAPL to CPP Conversion

CAPL to CPP Converter is used to convert the CAPL file (.can) to CPP (.cpp) files to be used with BUSMASTER. Once the CAPL file is selected for conversion, the entry for output file name will be automatically filled with input file name but with the extension of .cpp

Any database associated with the CAPL file has to be added using the Add DBC file option. The DBC file will be converted to DBF file and will be used for conversion. The converted DBF file will saved in the same path by default.

Select the convert button to convert the file

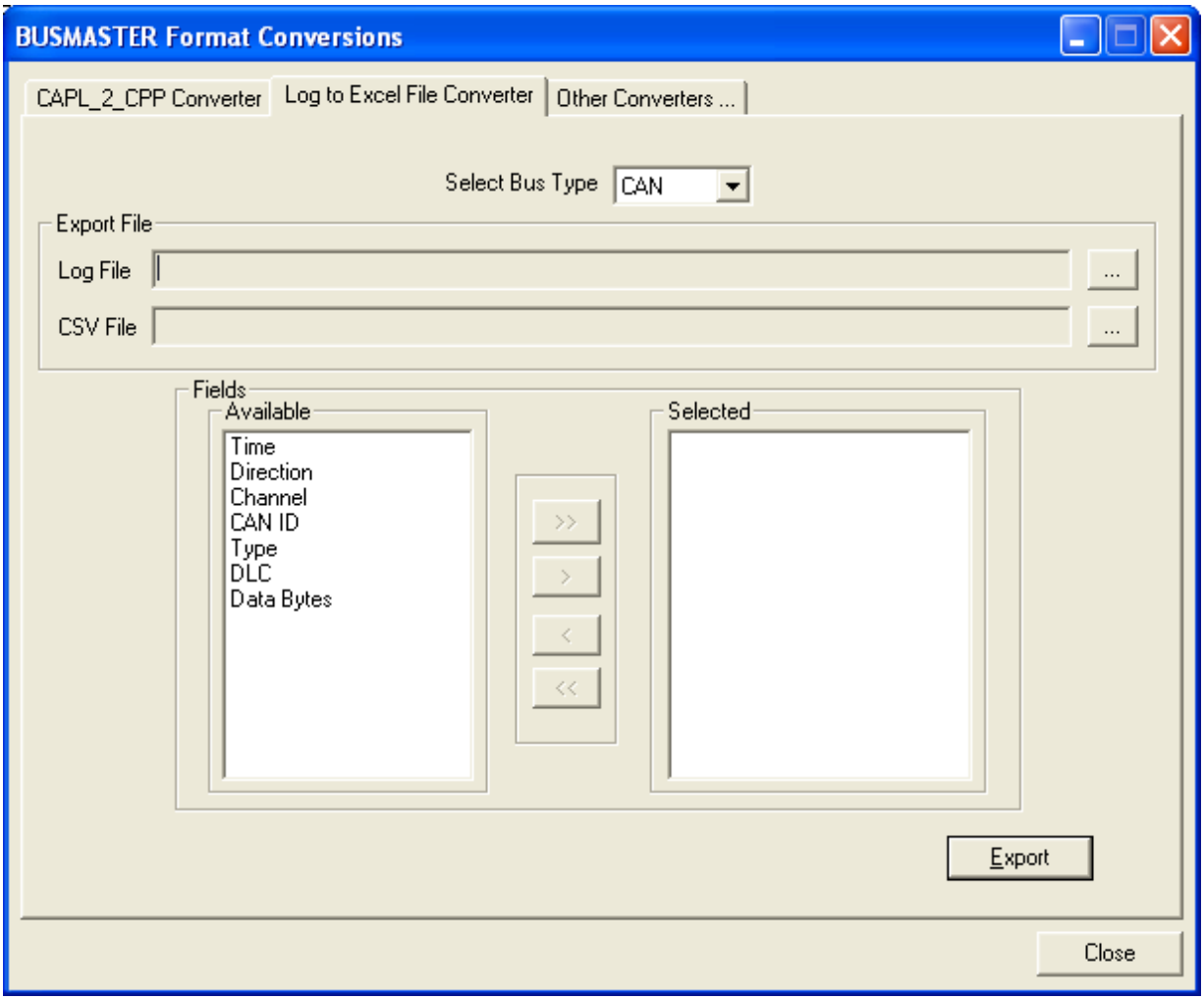


Log To Excel Converter

Log to Excel Converter is used to convert the log file (.log) in to an .xls file. The messages recorded by BUSMASTER using the logging feature can be neatly updated in a .xls file using this conversion.

Once the input file is selected the output file is filled automatically in the same path of input file with input file's name with the extension of .xls. Either specific fields or all the fields can be used for conversion. Only the selected fields data will be converted.

Select the Export button to convert the file

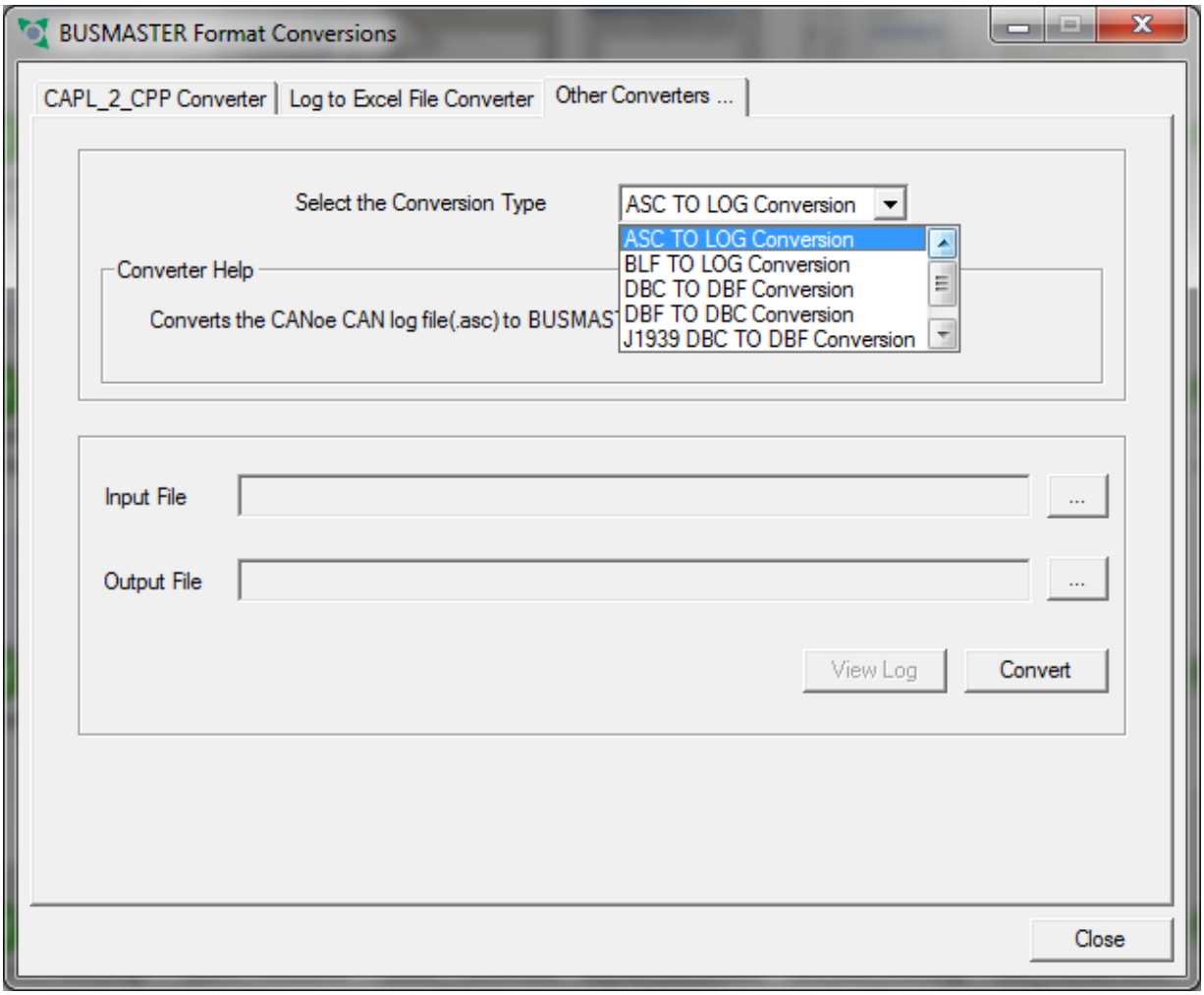


Other Converters

This supports the following conversion:

- ASC to LOG - Converts log files in ASC format to BUSMASTER format files (.log)
- DBC to DBF - Converts database files in DBC format to BUSMASTER format files (.dbf)
- DBF to DBC - Converts BUSMASTER database files to DBC format files (.dbc)
- J1939 DBC to DBF - Converts J1939 database files in DBC format to BUSMASTER format files (.dbf)
- LOG to ASC - Converts BUSMASTER log files to ASC format files (.asc)

Select the convert button to convert the files



API Reference

STCAN_MSG Structure

STCAN_MSG Structure Definition

```
struct STCAN_MSG
{
    unsigned int  m_unMsgID;     // 11/29 Bit- Message ID
    unsigned char m_ucEXTENDED;  // true, for (29 Bit) Frame
    unsigned char m_ucRTR;       // true, for Remote Request
    unsigned char m_ucDLC;       // Data len (0..8)
    union
          {
                  unsigned char      m_aucData[8];  // Byte Data
                  unsigned short int m_auwData[4];  // Word Data
                  unsigned long  int m_aulData[2];  // Long Data
          } m_sWhichBit;          // Data access member
     unsigned char m_ucChannel;
};
```

Required Include header file is struct.h

```
STCAN_MSG sMsg;

// Initialise message structure
sMsg.m_unMsgID = 0x100;              // Message ID
sMsg.m_ucEXTENDED = FALSE;           // Standard Message type
sMsg.m_ucRTR = FALSE;                // Not RTR type
```

```
sMsg.m_ucDLC = 8;                       // Length is 8 Bytes
sMsg.m_sWhichBit.m_aulData[0] = 10;  // Lower 4 Bytes
sMsg.m_sWhichBit.m_aulData[1] = 20;  // Upper 4 Bytes
sMsg.m_ucChannel = 1;                   // First CAN channel

// Send the message
SendMsg(sMsg);
```

SCAN_ERR Structure Definition

```
struct SCAN_ERR
{
    unsigned char m_ucTcError;      // Tx Error Counter Value
    unsigned char m_ucRxError;      // Rx Error Counter Value
    unsigned char m_ucChannel;      // Channel Nember
};
```

Required Include header file is struct.h

```
// Error Active Handler which will print error counter values
 and channel number
void OnError_Active(SCAN_ERR ErrorMsg)
{
  Trace( "Tx Error: %d Rx Error: %d Channel: %d",
         ErrorMsg.m_ucTxError,
         ErrorMsg.m_ucRxError,
         ErrorMsg.m_ucRxError );
}
```

Accessing database message signal values

Database message structures can be meaningfully interpreted. Database message structures will have signal members as defined in the database. Signal raw value can be directly assigned by using member of database message structure with the signal name.

CAN_Request is a database message that has signals Sig1, Sig2 and Sig3. Each signal is 2 bytes of length. To assign raw value of a signal use message name structure and use signal name as member.

```
// Message Declaration
CAN_Request sMsgStruct = { 0x100, 0, 0, 8, { 0, 0, 0, 0, 0, 0,
 0, 0 } };

// Use signal member

// Sig1
sMsgStruct.m_sWhichBit.Sig_1 = 10;

// Sig2
sMsgStruct.m_sWhichBit.Sig_2 = 20;

// Sig3
sMsgStruct.m_sWhichBit.Sig_3 = 30;

// Send the message now
SendMsg(*((STCAN_MSG *)&sMsgStruct));
```

Note: Right click on edit area of function editor. Select "Insert Message" or "Insert Signal" option to insert message structure or signal structure. Select the option "Yes, I want to declare selected message structure variable" option in the "Message and Signal List" to initialise message with its struct definition.

Required Include header file Unions.h

Note:

- Unions.h file will be automatically generated by BUSMASTER during database import.

- This file will be in the database file directory

API Listing

BUSMASTER API Listing

SendMsg : To send a CAN frame

Synopsis

```
UINT SendMsg ( STCAN_MSG )
```

Description

This function will put the message on the CAN bus. The message structure STCAN_MSG will be filled with ID, length, frame format and data. Big/Little endian packing will be taken care if it is a database message.

Inputs

STCAN_MSG - CAN Message Structure

Returns

Zero on successful transmisstion. Non-zero value on failure.

EnableLogging : To start logging

Synopsis

```
UINT EnableLogging ( )
```

Description

This function will enable logging. The return value of this function will be 0 or 1.

Inputs

-

Returns

A value zero indicate failure condition while a value 1 indicate a success condition. This function can return 0 in case logging is already ON

DisableLogging : To stop logging

Synopsis

```
UINT DisableLogging ( )
```

Description

This function will disable logging. The return value of this function will be 0 or 1.

Inputs

-

Returns

A value zero indicate failure condition while a value 1 indicate a success condition. This function can return 0 in case logging is already OFF

WriteToLogFile : To send string to log file

Synopsis

```
UINT WriteToLogFile ( char* msg )
```

Description

This function will output text passed as parameter "msg" to all log files. The return value of this function will be 0 or 1.

Inputs

msg - Pointer to characterarray

Returns

A value zero indicate failure condition while a value 1 indicate a success condition. This function can return 0 in case logging is OFF or user has passed a NULL pointer.

Trace : To send string to Trace window

Synopsis

```
UINT Trace ( char* format, ... )
```

Description

This function will format the passed parameters based on format specified and will show the formatted text inTRACE window. The return value of this function will be 0 or 1.

Inputs

msg - Pointer to character array

Returns

A value zero indicate failure condition while a value 1 indicate a success condition. This function can return 0 in case user has passed a NULL pointer. If the TRACE window is visible, it will be made visible

ResetController : To reset CAN controller

Synopsis

```
void ResetController ( BOOL bResetType)
```

Description

This function will reset the controller. If the parameter passed is TRUE, a hardware reset will be given to controller. In case of hardware reset, the buffer of controller will be flushed off and error counter value will be set to zero. If the parameter passed is FALSE, a software reset will be given to controller. Only driver buffer will be cleared. The status of controller error counter will not be effected.

Inputs

bResetType - 1 for Hardware reset of CAN controller 0 for Software reset of CAN controller

Returns

-

GoOnline : To enable all event handlers

Synopsis

```
UINT GoOnline ( )
```

Description

This function will enable all handlers. The return value of this function will be 0 or 1. This function can return 0 in case handlers are already enabled, i.e. "All Handler" toolbar/menu is already enabled.

Inputs

-

Returns

A value zero indicate failure condition while a value 1 indicate a success condition.

GoOffline : To disable all event handlers

Synopsis

```
UINT GoOffline ( )
```

Description

This function will disable all handlers. The return value of this function will be 0 or 1. This function can return 0 in case handlers are already disabled, i.e. "All Handler" toolbar/menu is already disabled.

Inputs

-

Returns

A value zero indicate failure condition while a value 1 indicate a success condition.

Disconnect : To disconnect CAN controller from CAN bus

Synopsis

```
UINT Disconnect (DWORD dwClientId )
```

Description

This function will disconnect the tool from CAN bus. The return value of this function will be 0 or 1. This function can return 0 in case tool is already disconnected. dwClientId is reserved for future use.

Inputs

Client ID. Currently unused.

Returns

A value zero indicate failure condition while a value 1 indicate a success condition.

Connect : To connect CAN controller to CAN bus

Synopsis

```
UINT Connect (DWORD dwClientId )
```

Description

This function will connect the tool to CAN bus. The return value of this function will be 0 or 1. This function can return 0 in case tool is already connected. dwClientId is reserved for future use.

Inputs

Client ID. Currently unused.

Returns

A value zero indicate failure condition while a value 1 indicate a success condition.

StartTimer : To start a timer in specific mode

Synopsis

```
UINT StartTimer ( char* strTimerName, UINT nTimerMode )
```

Description

This function will start timer having name passed as parameter strTimerName in monoshot or cyclic mode. The function takes first parameter as timer name and second as mode, monoshot or cyclic. If the named timer is already running or timer name is not matched, the function will return FALSE. Otherwise function be return TRUE.

Inputs

strTimerName - Name of the timer. i.e. OnTimer_Tester_Present_100 nTimerMode - Mode of the timer. 1 - Start in Cyclic mode 0 - Start in Monoshot mode

Returns

1 on success. 0 if the timer is already running or timer name not found

StopTimer : To stop a running timer

Synopsis

```
UINT StopTimer ( char* strTimerName)
```

Description

This function will stop timer having name passed as parameter strTimerName. If the named timer is not running or timer name is not matched, the function will return FALSE. Otherwise function be return TRUE.

Inputs

strTimerName - Name of the timer. i.e. OnTimer_Tester_Present_100

Returns

1 on success. 0 if the timer is already running or timer name not found

SetTimerVal : To set a new time value for a timer

Synopsis

```
UINT SetTimerVal ( char* strTimerName, UINT nTimeInterval )
```

Description

This function will change the timer value. The timer value and name of timer whose time value is to be changed has to be passed through the parameter strTimerName. The second parameter will take time value. If the timer is

running in cyclic mode or next instance of timer is to be fired this function will return FALSE otherwise if will return TRUE.

Inputs

strTimerName - Name of the timer. i.e. OnTimer_Tester_Present_100 nTimeInterval - Time value of the timer.

Returns

1 on success. 0 if the timer is already running or timer name not found BOOL

EnableDisableMsgTx: To enable or disable message transmission from the node

Synopsis

```
BOOL EnableDisableMsgTx ( BOOL bEnable)
```

Description

This function will enable or disable message transmission from a node. User can pass parameter as TRUE to enable and FALSE to disable outgoing message from a node.The node can receive the messages in both state. Function will return TRUE, if state change was successful otherwise it will return FALSE.

Inputs

bEnable - TRUE to Enable message transmission. FALSE to disable

Returns

TRUE success. FALSE if the handler is already in the specified state

hGetDllHandle: To get handle of dll attached to a node from the node

Synopsis

```
HANDLE hGetDllHandle ( char* strNodeName)
```

Description

This function returns the handle of the dll attached to a node. The node name will be passed as parameter.

Inputs

Node name

Returns

Dll handle on success else NULL

J1939 API Reference

J1939 Structures

```
/* TYPES OF TIMEOUT */
typedef enum ETYPE_TIMEOUT
{
  TYPE_TO_BROADCAST = 0,
  TYPE_TO_RESPONSE,
  TYPE_TO_HOLDING,
  TYPE_TO_T1,
  TYPE_TO_T2,
  TYPE_TO_T3,
  TYPE_TO_T4
```

```
};


/* TYPES OF ACKNOWLEDGEMENT */
typedef enum ETYPE_ACK { ACK_POS = 0, ACK_NEG }; /* ECU NAME STRUCTURE */


typedef struct tagSECU_NAME
{
  UINT32 m_unID : 21;
  UINT32 m_unSAE_MF_CODE : 11;
  BYTE m_byECU_INST : 3;
  BYTE m_byFUNC_INST : 5;
  BYTE m_bySAE_FUNCTION : 8;
  BYTE m_bySAE_RESERVED : 1;
  BYTE m_bySAE_VHL_SYS : 7;
  BYTE m_byVHL_SYS_INST : 4;
  BYTE m_bySAE_IND_GRP : 3;
  BYTE m_byARB_ADRS_CPL : 1;
} STRUCT_ECU_NAME;


/* J1939 PGN structure */
typedef struct tagSTRUCT_PGN
{
  BYTE m_byPDU_Specific : 8; // PDU Specific (PS)
  BYTE m_byPDU_Format : 8; // PDU Format (PF), Indicates Peer_2_peer or
 Broadcast.
  BYTE m_byDataPage : 1; // DataPage (DP), Set to 0 currently.
  BYTE m_byReserved : 1; // Reserved, Set to 0.
  BYTE m_byPriority : 3;
} STRUCT_PGN;


typedef union tagUPGN
{
  UINT32 m_unPGN : 21;
  STRUCT_PGN m_sPGN;
} UNION_PGN;

/* J1939 Extended 29 bit ID */
typedef struct tagSTRUCT_29_BIT_ID
{
  BYTE m_bySrcAddress : 8; // Sender node address.
  UNION_PGN m_uPGN; // Parameter group number(PGN). SAE lists various PGNS
 and its SPNS.
} STRUCT_29_BIT_ID;


typedef union tag29BitID
{
  UINT32 m_unExtID : 29;
  STRUCT_29_BIT_ID m_s29BitId;
} UNION_29_BIT_ID;


/* J1939 message type */
typedef enum EJ1939_MSG_TYPE
{
  MSG_TYPE_NONE = 0x0,
  MSG_TYPE_COMMAND,
  MSG_TYPE_REQUEST,
  MSG_TYPE_DATA,
  MSG_TYPE_BROADCAST,
  MSG_TYPE_ACKNOWLEDGEMENT,
  MSG_TYPE_GROUP_FUNCTIONS,
  MSG_TYPE_NM_ACL,
  MSG_TYPE_NM_RQST_ACL,
```

```
  MSG_TYPE_NM_CMD_ADDRESS,
  MSG_TYPE_NM_TPCM_BAM,
  MSG_TYPE_NM_TPCM_RTS,
  MSG_TYPE_NM_TPCM_CTS,
  MSG_TYPE_NM_TPCM_EOM_ACK,
  MSG_TYPE_NM_TPCM_CON_ABORT,
  MSG_TYPE_NM_TPDT
};


typedef enum EDIRECTION
{
  DIR_RX = 'R',
  DIR_TX = 'T',
  DIR_ALL
};


/* J1939 message properties */
typedef struct tagSTJ1939_MSG_PROPERTIES
{
  UINT64 m_un64TimeStamp; // Timestamp.
  BYTE m_byChannel; // Channel number.
  enum EJ1939_MSG_TYPE m_eType;
  enum EDIRECTION m_eDirection; // DIR_TX, DIR_RX
  UNION_29_BIT_ID m_uExtendedID; // 29 bit extended ID
} STJ1939_MSG_PROPERTIES;


typedef struct tagSTJ1939_MSG
{
  STJ1939_MSG_PROPERTIES m_sMsgProperties;
  UINT m_unDLC; // Data length. 0 <= m_unDLC <= 1785 bytes.
  BYTE* m_pbyData; // J1939 message data.
} STJ1939_MSG;
```

Required Include header file is struct_J1939.h

J1939 API Listing

BUSMASTER J1939 API Listing

SendMsg : To send a J1939 message

Synopsis

```
UINT SendMsg ( STJ1939_MSG* )
```

Description

This function will put the message on the J1939 network. The message structure STJ1939_MSG will be filled with ID, length, data, channel.

Inputs

STJ1939_MSG* - Pointer to J1939 Message Structure

Returns

1 on successful transmisstion. 0 value on failure.

EnableLogging : To start logging

Synopsis

```
UINT EnableLogging ( )
```

Description

This function will enable logging. The return value of this function will be 0 or 1.

Inputs

-

Returns

A value zero indicate failure condition while a value 1 indicate a success condition. This function can return 0 in case logging is already ON

DisableLogging : To stop logging

Synopsis

```
UINT DisableLogging ( )
```

Description

This function will disable logging. The return value of this function will be 0 or 1.

Inputs

-

Returns

A value zero indicate failure condition while a value 1 indicate a success condition. This function can return 0 in case logging is already OFF

WriteToLogFile : To send string to log file

Synopsis

```
UINT WriteToLogFile ( char* msg )
```

Description

This function will output text passed as parameter "msg" to all log files. The return value of this function will be 0 or 1.

Inputs

msg - Pointer to characterarray

Returns

A value zero indicate failure condition while a value 1 indicate a success condition. This function can return 0 in case logging is OFF or user has passed a NULL pointer.

Trace : To send string to Trace window

Synopsis

```
UINT Trace ( char* format, ... )
```

Description

This function will format the passed parameters based on format specified and will show the formatted text inTRACE window. The return value of this function will be 0 or 1.

Inputs

msg - Pointer to character array

Returns

A value zero indicate failure condition while a value 1 indicate a success condition. This function can return 0 in case user has passed a NULL pointer. If the TRACE window is visible, it will be made visible

ResetController : To reset CAN controller

Synopsis

```
void ResetController ( BOOL bResetType)
```

Description

This function will reset the controller. If the parameter passed is TRUE, a hardware reset will be given to controller. In case of hardware reset, the buffer of controller will be flushed off and error counter value will be set to zero. If the parameter passed is FALSE, a software reset will be given to controller. Only driver buffer will be cleared. The status of controller error counter will not be effected.

Inputs

bResetType - 1 for Hardware reset of CAN controller 0 for Software reset of CAN controller

Returns

-

GoOnline : To enable all event handlers

Synopsis

```
UINT GoOnline ( )
```

Description

This function will join all the nodes to the J1939 network. The return value of this function will be 0 or 1.

Inputs

-

Returns

A value 1 indicate success condition while a value 0 indicate a failure condition.

GoOffline : To disable all event handlers

Synopsis

```
UINT GoOffline ( )
```

Description

This function will remove all nodes from J1939 network. The return value of this function will be 0 or 1.

Inputs

-

Returns

A value zero indicate failure condition while a value 1 indicate a success condition.

Disconnect : To disconnect CAN controller from CAN bus

Synopsis

```
UINT Disconnect (DWORD dwClientId )
```

Description

This function will disconnect the tool from CAN bus. The return value of this function will be 0 or 1. This function can return 0 in case tool is already disconnected. dwClientId is reserved for future use.

Inputs

Client ID. Currently unused.

Returns

A value zero indicate failure condition while a value 1 indicate a success condition.

Connect : To connect CAN controller to CAN bus

Synopsis

```
UINT Connect (DWORD dwClientId )
```

Description

This function will connect the tool to CAN bus. The return value of this function will be 0 or 1. This function can return 0 in case tool is already connected. dwClientId is reserved for future use.

Inputs

Client ID. Currently unused.

Returns

A value zero indicate failure condition while a value 1 indicate a success condition.

StartTimer : To start a timer in specific mode

Synopsis

```
UINT StartTimer ( char* strTimerName, UINT nTimerMode )
```

Description

This function will start timer having name passed as parameter strTimerName in monoshot or cyclic mode. The function takes first parameter as timer name and second as mode, monoshot or cyclic. If the named timer is already running or timer name is not matched, the function will return FALSE. Otherwise function be return TRUE.

Inputs

strTimerName - Name of the timer. i.e. OnTimer_Tester_Present_100 nTimerMode - Mode of the timer. 1 - Start in Cyclic mode 0 - Start in Monoshot mode

Returns

1 on success. 0 if the timer is already running or timer name not found

StopTimer : To stop a running timer

Synopsis

```
UINT StopTimer ( char* strTimerName)
```

Description

This function will stop timer having name passed as parameter strTimerName. If the named timer is not running or timer name is not matched, the function will return FALSE. Otherwise function be return TRUE.

Inputs

strTimerName - Name of the timer. i.e. OnTimer_Tester_Present_100

Returns

1 on success. 0 if the timer is already running or timer name not found

SetTimerVal : To set a new time value for a timer

Synopsis

```
UINT SetTimerVal ( char* strTimerName, UINT nTimeInterval )
```

Description

This function will change the timer value. The timer value and name of timer whose time value is to be changed has to be passed through the parameter strTimerName. The second parameter will take time value. If the timer is running in cyclic mode or next instance of timer is to be fired this function will return FALSE otherwise if will return TRUE.

Inputs

strTimerName - Name of the timer. i.e. OnTimer_Tester_Present_100 nTimeInterval - Time value of the timer.

Returns

1 on success. 0 if the timer is already running or timer name not found BOOL

EnableDisableMsgTx: To enable or disable message transmission from the node

Synopsis

```
BOOL EnableDisableMsgTx ( BOOL bEnable)
```

Description

This function will enable or disable message transmission from a node. User can pass parameter as TRUE to enable and FALSE to disable outgoing message from a node.The node can receive the messages in both state. Function will return TRUE, if state change was successful otherwise it will return FALSE.

Inputs

bEnable - TRUE to Enable message transmission. FALSE to disable

Returns

TRUE success. FALSE if the handler is already in the specified state

hGetDllHandle: To get handle of dll attached to a node from the node

Synopsis

```
HANDLE hGetDllHandle ( char* strNodeName)
```

Description

This function returns the handle of the dll attached to a node. The node name will be passed as parameter.

Inputs

Node name

Returns

Dll handle on success else NULL

RequestPGN: To request PGN from a node.

Synopsis

```
UINT RequestPGN ( UINT PGN, BYTE DestAdres, UINT Channel)
```

Description

This function will request a PGN from a node in the network.

Inputs

PGN - PGN to be requested.
DestAdres - From the node.
Channel - Channel number

Returns

1 on success. 0 on failure.

SendAckMsg: To send a acknowlegde message

Synopsis

```
UINT SendAckMsg ( UINT PGN, BYTE AckType, BYTE DestAdres, UINT Channel)
```

Description

This function will be used to send a acknowledgement message based on the request.

Inputs

PGN - PGN to requested.
AckType - 0 for positive, 1 for negative acknowledgement.
DestAdres - Destination node.
Channel - Channel number.

Returns

1 on success. 0 on failure.

ClaimAddress: To claim a different address for current node

Synopsis

```
UINT ClaimAddress ( BYTE Address, UINT Channel)
```

Description
This function will claim a different address for the current node.

Inputs

Address - Address to be claimed.
Channel - Channel number.

Returns

1 on success. 0 on failure.

RequestAddress: To request addresses of currently active nodes in the network

Synopsis
```
UINT RequestAddress ( UINT Channel)
```

Description

This function will request the address of each node in the J1939 network.

Inputs

Channel - Channel number.

Returns

TRUE success. FALSE if the handler is already in the specified state

CommandAddress: To command a address for a node

Synopsis
```
UINT CommandAddress (UINT64 EcuName, BYTE NewAddress, UINT Channel)
```

Description

This function will command a address to the node having ECU NAME as specified.

Inputs

EcuName - ECU NAME of a node for which the address has to be commanded.
NewAddress - The new address.
Channel - Channel number.

Returns

TRUE success. FALSE if the handler is already in the specified state

SetTimeout: To configure flow control timeouts of J1939 network

Synopsis
```
UINT SetTimeout (BYTE TimeoutType, UINT TimeoutValue )
```

Description

This function can be used to configure flow control timeouts in J1939 network.

Inputs

TimeoutType - Timeout type. Possible values are
a. Tb (0): Time interval between two packets in broadcast transmission.

b. Tr (1): Maximum wait period for a sender without receiving response from the receiver.
c.Th (2): Time interval between two 'Clear to Send' message when delaying the data.
d.T1 (3): Maximum wait period for a receiver when more packets were expected.
e.T2 (4): Maximum wait period for a receiver to receive data packets after sending 'Clear to Send' message.
f.T3 (5): Maximum wait period for a sender to receive 'End of Message Acknowledgement' after sending last data packet.
g. T4 (6): Maximum wait period for a sender to receive another 'Clear to Send' message after receiving one to delay the data.
TimeoutValue(ms) - Value to be set for the corresponding timeout type.

Returns

TRUE success. FALSE if the handler is already in the specified state

COM Interface

BUSMASTER COM interface

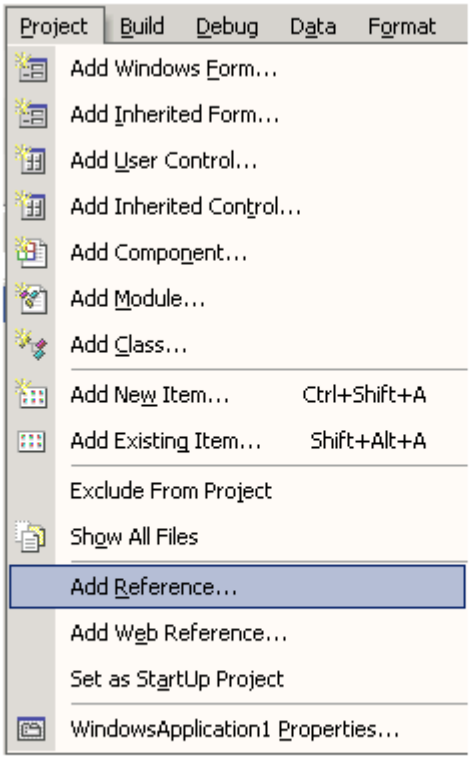
Using BUSMASTER Automation Object:

User can use all the APIs exposed by BUSMASTER, as COM interface functions in his own application by following ways:

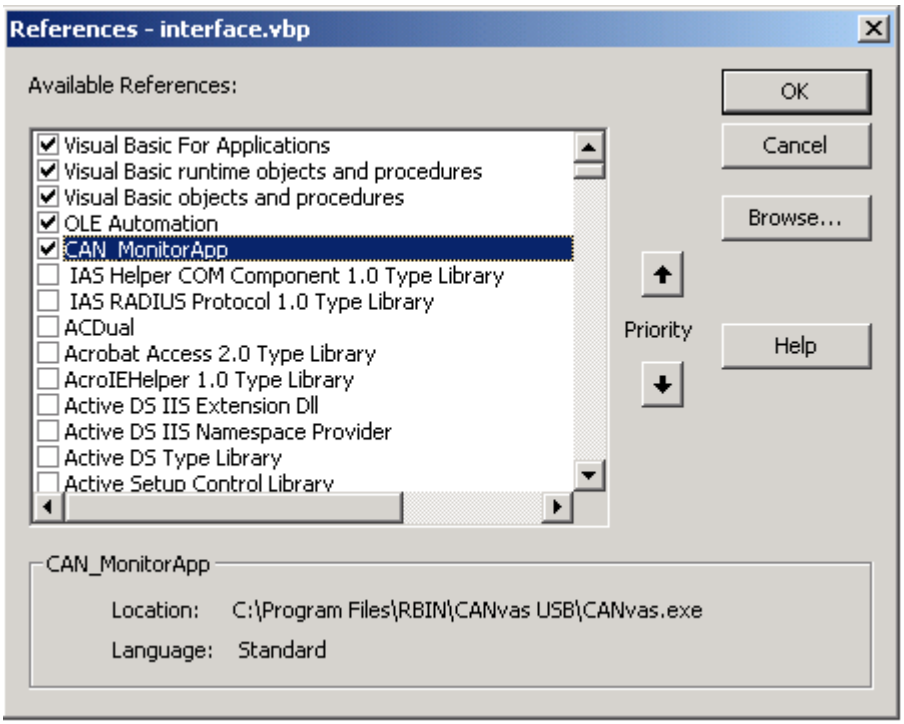
FROM VB:

If the client application is developed using VB the steps are:

1. Project->Add Reference ie.



2. Select the CAN_Monitor 1.0 Type Library



Now all the BUSMASTER COM APIs can be used in the client application.Once the VB project is configured to use CAN_Monitor type library, a global variable is needed to be declared and initialised so that the COM server can be accessed.This can be accomplished using following statement:

```
Dim gBUSMASTERApp As CAN_MonitorApp.Application
Set gBUSMASTERApp  = New CAN_MonitorApp.Application
```

Now the varible gBUSMASTERApp can be used to access all the COM members.

> For connecting the tool following code is required:
>
> ```
> gBUSMASTERApp  .Connect 1
> ```

From C++

Let's start with a very simple C++ application. Make a simple dialog-based application with the class wizard, be it an MFC or an ATL/WTL application. Just make sure that :CoInitialize() and CoUninitialize() are called somewhere (that is done automatically in ATL applications). Put a button on the dialog somewhere, wire it up, and put the following in the message handler for the BN_CLICKED handler:

```
HResult hr;
hr = ::CoCreateInstance(CLSID_Application, NULL, CLSCTX_LOCAL_SERVER,
 IID_IApplication, (void**)&m_IApplication);
if(SUCCEEDED(hr))
  if (m_IApplication) {
    m_IApplication->Connect ( 1 );
  }
}
```

In the header for the dialog, declare a member like this:

```
IApplication* m_IApplication;
```

Now, all you need to do is include the file CAN_Monitor_Interface.h which is provided in the BUSMASTER installation folder.When you go looking for this file, you'll notice another file: CAN_Monitor_Interface.c. This file contains the implementation of the interface and is needed by the linker. So, again, you can copy it, or add it to your project directly.

Now, build your application, click the button you've made, and - there is your application!

To receive CAN messages from Busmaster makes use of the new interface_IAppEvents (connection points).

To know more, refer Example folder in BUSMASTER installation folder.

COM Interface API Listing

BUSMASTER COM Interface API Listing

Connect : To connect BUSMASTER to the bus

Synopsis

HRESULT Connect(BOOL bConnect);

Description

This function connects / disconnects BUSMASTER to the bus.

Inputs

BOOL bConnect: TRUE - connect, FALSE - Disconnect

Cause of failure

NA

GetMsgInfo : Retrieves the message parameters from the loaded database, given the message name

Synopsis

HRESULT GetMsgInfo(BSTR MsgName,sMESSAGESTRUCT *sMsgStruct);

Description

This function will get the details about a database message.

Inputs

Message name, Structure sMESSAGESTRUCT { double m_dMessageCode; double m_dNumberOfSignals; double m_dMessageLength; BOOL m_bMessageFrameFormat; int m_nMsgDataFormat; }

Cause of failure

message name not in database,data base file is not imported to BUSMASTER

GetNetworkStatistics : To get all the statistics of a channel

Synopsis

HRESULT GetNetworkStatistics(int nChannel, sBUSSTATISTICS_USR *sStat);

Description

This function will provide the channel's statistics.

Inputs

Channel number and Pointer to the structuresCHANNELSTATISTICS { DOUBLE m_dBusLoad; DOUBLE m_dPeakBusLoad; float m_fTotalMsgCount; float m_unMsgPerSecond; float m_fTotalTxMsgCount; DOUBLE m_dTotalTxMsgRate; float m_fTxSTDMsgCount; DOUBLE m_dTxSTDMsgRate; float m_fTxEXTDMsgCount; DOUBLE m_dTxEXTMsgRate; float m_fTxSTD_RTRMsgCount; float m_fTxEXTD_RTRMsgCount; float m_fTotalRxMsgCount; DOUBLE m_dTotalRxMsgRate; float m_fRxSTDMsgCount; DOUBLE m_dRxSTDMsgRate; float m_fRxEXTDMsgCount; DOUBLE m_dRxEXTMsgRate; float m_fRxSTD_RTRMsgCount; float m_fRxEXTD_RTRMsgCount; float m_fErrorTxCount; DOUBLE m_dErrorTxRate; float m_fErrorRxCount; DOUBLE m_dErrorRxRate; float

m_fErrorTotalCount; DOUBLE m_dErrorRate; float m_fDLCCount; DOUBLE m_dBaudRate; DOUBLE m_dTotalBusLoad; int m_nSamples; DOUBLE m_dAvarageBusLoad; UCHAR m_ucTxErrorCounter; UCHAR m_ucRxErrorCounter; UCHAR m_ucTxPeakErrorCount; UCHAR m_ucRxPeakErrorCount; UCHAR m_ucStatus;}

Cause of failure

NA

GetErrorCounter : Getter for both Rx and Tx error, given the channel number

Synopsis

HRESULT GetErrorCounter(UCHAR *Tx, UCHAR *Rx, INT nChannel);

Description

This function will provide the TX and RX error count of the specified channel from BUSMASTER.

Inputs

Channel number, pointers to variables for RX and TX error

Cause of failure

NA

ImportDatabase : To import a database file in BUSMASTER

Synopsis

HRESULT ImportDatabase(BSTR DBFilePath);

Description

This function will import the specified file to BUSMASTER.

Inputs

Database file path

Cause of failure

Dlls are loaded, File absent

LoadConfiguration : To load a configuration file in BUSMASTER

Synopsis

HRESULT LoadConfiguration(BSTR FileName);

Description

This function will load the configuration file specified by client.

Inputs

Configuration file path.

Cause of failure

File absent, tool is connected, DLLs are loaded

SaveConfiguration : To save current configuration file

Synopsis

HRESULT SaveConfiguration();

Description

This function saves the current configuration file of BUSMASTER tool.

Inputs

-

Cause of failure

NA

SaveConfigurationAs : To save current configuration in a particular file

Synopsis

HRESULT SaveConfigurationAs(BSTR ConfigPath);

Description

To save current configuration in a particular configuration file.

Inputs

BSTR ConfigPath - Configuration file path.

Cause of failure

NA

RegisterClientForRx : To register Client for receiving messages

Synopsis

HRESULT RegisterClientForRx([in] USHORT usUniqueID, [out] BSTR* pEventName, [out] BSTR* pPIPEName);

Description

This function registers a client for receiving messages.

Inputs

[in]usUniqueId - The unquie Id the Client needs to provides while registering.

[out]pEventName - The event which gets notified on reception of a message. Client needs to wait on this event.

[out]pPIPEName - The Buffer on which the Rx messages will be written for the client.

Usage in COM Client

BSTR* pEventName;

BSTR* pPIPEName;

HRESULT hResult = m_IApplication->RegisterClientForRx(1,pEventName,pPipeName);

/*If HRESULT is S_OK the Client is registered with a client id of 1*/

Cause of failure

NA

UnRegisterClient : To Unregister a Client

Synopsis

HRESULT UnRegisterClient([in] USHORT usUniqueID);

Description

This function unregisters the registered Client

Inputs

usUniqueID - Client Id.

Usage in COM Client

HRESULT hResult = m_IApplication->UnRegisterClient(1); //Unregisters Client with id 1;

Cause of failure

NA

SendCANMSg : To send a CAN message

Synopsis

HRESULT SendCANMSg(CAN_MSGS *sMsg)

Description

This function will put the message on the CAN bus. The message structure CAN_MSGS will be filled with ID, length, frame format and data.

Inputs

CAN_MSGS - CAN Message Structure

Cause of failure

Tool not connected

GetApplication : Gets pointer to BUSMASTER Application

Description

Gets the pointer to BUSMASTER Application using which various operation in BUSMASTER is performed.

Synopsis

HRESULT GetApplication([out] IBusMasterApp** pApplication)

Inputs

[out] IBusMasterApp** pApplication - gets the pointer to BUSMASTER Application.

Usage in COM Client

IBusMasterApp** pApplication;

HRESULT hResult = GetApplication(pApplication);

Cause of failure

NA

StopLogging : To stop logging

Synopsis

HRESULT StopLogging()

Description

This function disables logging.

Inputs

NA

Cause of failure

NA

StartLogging : To start logging

Synopsis

HRESULT StartLogging();

Description

This function enables logging.

Inputs

NA

Cause of failure

Log file absent in configuration

AddLoggingBlock : To Add a Logging Block

Synopsis

HRESULT AddLoggingBlock(SLOGGINGBLOCK_USR* psLoggingBlock);

Description

This function is used to a add logging block.

Inputs

SLOGGINGBLOCK_USR* psLoggingBlock - pointer to logging block

Usage in COM Client

SLOGGINGBLOCK_USR* psLoggingBlock = new SLOGGINGBLOCK_USR();

m_IApplication->AddLoggingBlock(psLoggingBlock);

Cause of failure

NA

GetLoggingBlock : To get a particular Logging Block

Synopsis

HRESULT GetLoggingBlock([in] USHORT BlockIndex, [out] SLOGGINGBLOCK_USR* psLoggingBlock);

Description

This function gets a particular logging block

Inputs

[in] USHORT BlockIndex - The zero based logging block index.

[out] SLOGGINGBLOCK_USR* psLoggingBlock - return pointer to Logging block.

Usage in COM Client

SLOGGINGBLOCK_USR* psLoggingBlock

HRESULT hResult = m_IApplication->GetLoggingBlock(0,psLoggingBlock)//Gets pointer to first logging block.

Cause of failure

NA

RemoveLoggingBlock : To remove a particular logging block

Synopsis

HRESULT RemoveLoggingBlock([in] USHORT BlockIndex);

Description

This function removes a particular logging block

Inputs

USHORT BlockIndex - The zero based logging block index

Cause of failure

Will fail in case block index passed is wrong.

GetLoggingBlockCount : Getter for total number of logging blocks

Synopsis

HRESULT GetLoggingBlockCount([out] USHORT* BlockCount)

Description

This function is a getter of logging blocks defined.

Inputs

USHORT* BlockCount = An [out] parameter for the logging block count.

Cause of failure

NA

ClearLoggingBlockList : To Clear Logging block list

Synopsis

HRESULT ClearLoggingBlockList(void);

Description

This function clears the logging block list.

Inputs

void

Cause of failure

NA

WriteToLogFile : Writes a text in the log file currently open

Synopsis

HRESULT WriteToLogFile(USHORT BlockIndex, BSTR pcStr);

Description

This function writes a text in the log file currently open.

Inputs

bstrStr - The input string in BSTR

Cause of failure

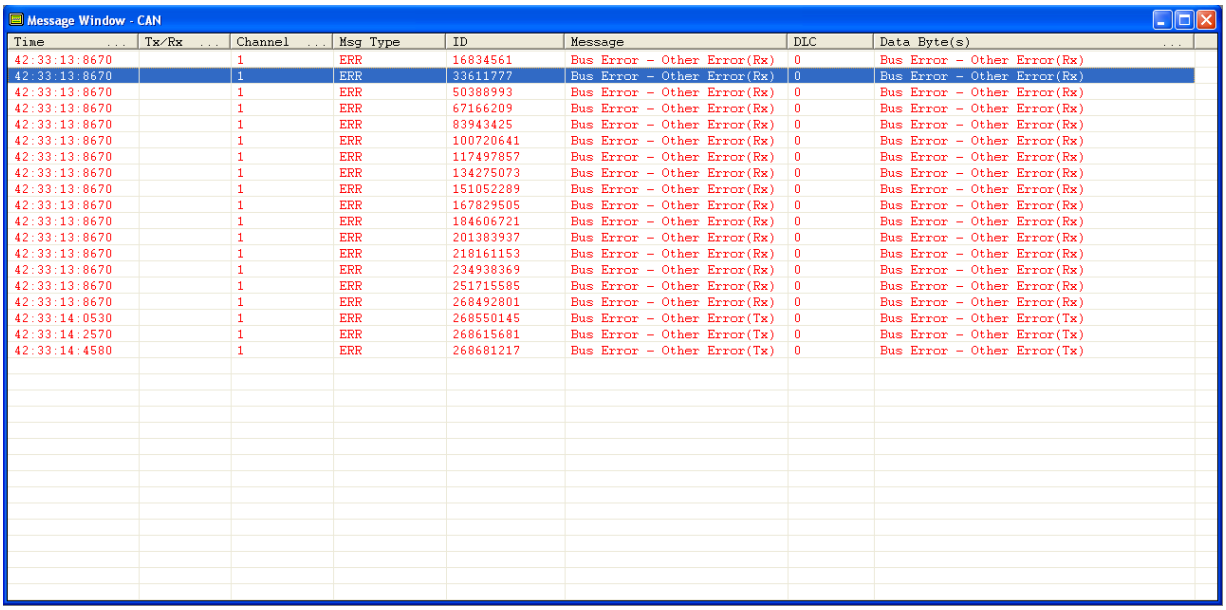
Logging not enabled, log file not present

Usage in COM Client

```
BSTR bstr;
bstr = SysAllocString(L"In CanSendMsg1 : ");
m_IApplication->WriteToLogFile(0, bstr);
SysFreeString(bstr);
```

Know About SubErrors

The enhanced view of error display in USB version of BUSMASTER is, as shown in the picture below.The SubErrors are not displayed in parallel port version of BUSMASTER.The Sub error value corressponds to the error value given by CAN controller.

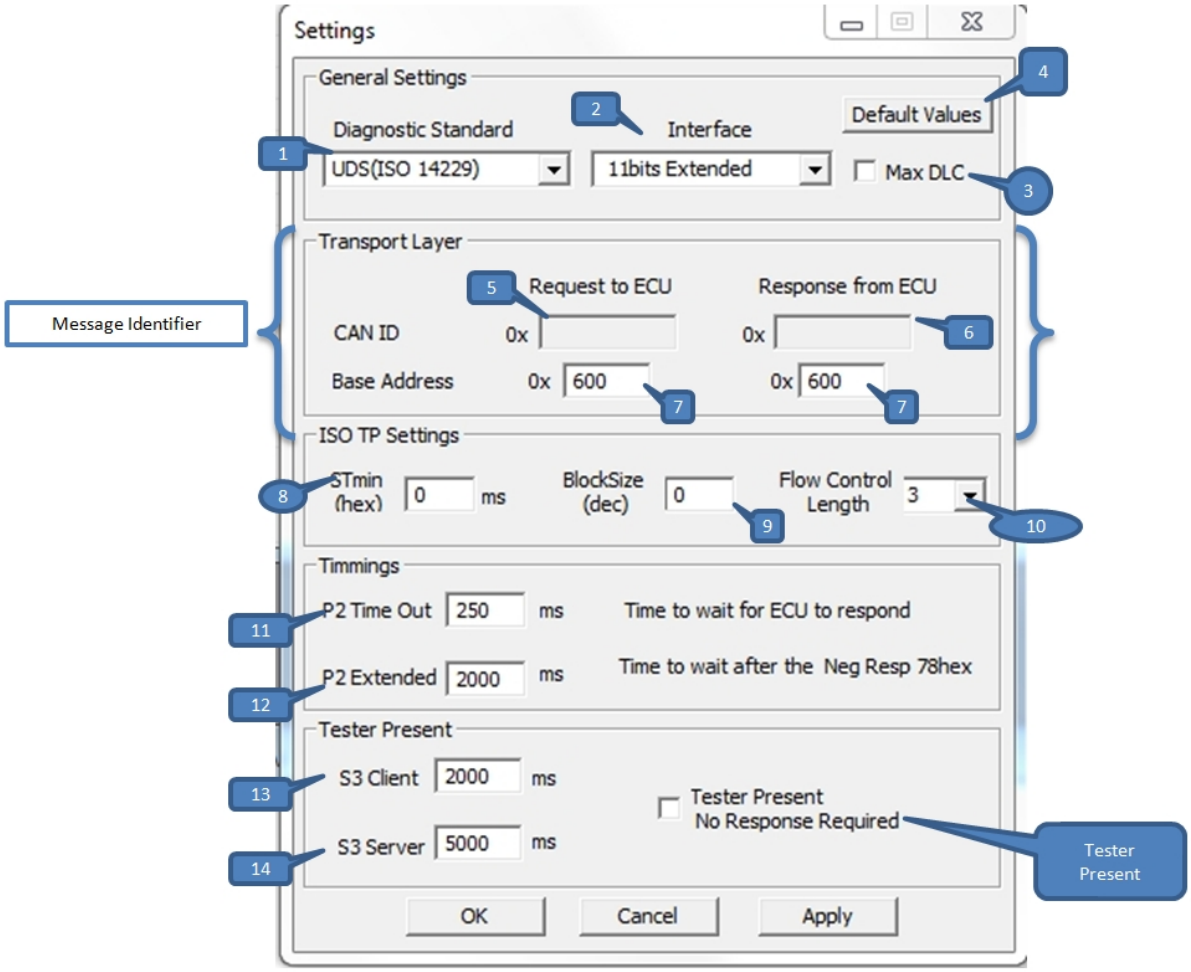

Message Window - CAN
Time
Tx/Rx
Channel
Msg Type
ID
Message
DLC
Data Byte(s)
42:33:13:8670 1 ERR 16834561 Bus Error - Other Error(Rx) 0 Bus Error - Other Error(Rx)
42:33:13:8670 1 ERR 33611777 Bus Error - Other Error(Rx) 0 Bus Error - Other Error(Rx)
42:33:13:8670 1 ERR 50388993 Bus Error - Other Error(Rx) 0 Bus Error - Other Error(Rx)
42:33:13:8670 1 ERR 67166209 Bus Error - Other Error(Rx) 0 Bus Error - Other Error(Rx)
42:33:13:8670 1 ERR 83943425 Bus Error - Other Error(Rx) 0 Bus Error - Other Error(Rx)
42:33:13:8670 1 ERR 100720641 Bus Error - Other Error(Rx) 0 Bus Error - Other Error(Rx)
42:33:13:8670 1 ERR 117497857 Bus Error - Other Error(Rx) 0 Bus Error - Other Error(Rx)
42:33:13:8670 1 ERR 134275073 Bus Error - Other Error(Rx) 0 Bus Error - Other Error(Rx)
42:33:13:8670 1 ERR 151052289 Bus Error - Other Error(Rx) 0 Bus Error - Other Error(Rx)
42:33:13:8670 1 ERR 167829505 Bus Error - Other Error(Rx) 0 Bus Error - Other Error(Rx)
42:33:13:8670 1 ERR 184606721 Bus Error - Other Error(Rx) 0 Bus Error - Other Error(Rx)
42:33:13:8670 1 ERR 201383937 Bus Error - Other Error(Rx) 0 Bus Error - Other Error(Rx)
42:33:13:8670 1 ERR 218161153 Bus Error - Other Error(Rx) 0 Bus Error - Other Error(Rx)
42:33:13:8670 1 ERR 234938369 Bus Error - Other Error(Rx) 0 Bus Error - Other Error(Rx)
42:33:13:8670 1 ERR 251715585 Bus Error - Other Error(Rx) 0 Bus Error - Other Error(Rx)
42:33:13:8670 1 ERR 268492801 Bus Error - Other Error(Rx) 0 Bus Error - Other Error(Rx)
42:33:14:0530 1 ERR 268550145 Bus Error - Other Error(Tx) 0 Bus Error - Other Error(Tx)
42:33:14:2570 1 ERR 268615681 Bus Error - Other Error(Tx) 0 Bus Error - Other Error(Tx)
42:33:14:4580 1 ERR 268681217 Bus Error - Other Error(Tx) 0 Bus Error - Other Error(Tx)

Diagnostics

Diagnostics Settings

Diagnostics settings window is used to set the settings for transmitting diagnostics requests and for receiving diagnostics response messages.

To configure diagnostic settings use **CAN->Diagnostics->Settings** menu.This will display the Window as shown below.



1. **Diagnostics Standard**

   To select diagnostics standard UDS (ISO 14229) or ISO 14230
2. **Interface**

   To select the type of the interface 11 bit or 29 bit interface
3. **Max DLC**

   If checked, the data length of the messages transmitted will be set to 8 bytes even if the data length of the message is less than 8 bytes
4. **Default Values**

   To reset to default settings
5. **CAN ID (Request to ECU)**

   To set the identifier of the diagnostic request message that is to be transmitted
6. **CAN ID (Response from ECU)**

   To set the identifier of the diagnostic response message that is to be received
7. **Base address**

   Indicates the base of the 11 bit message identifier. Enabled only if the interface selected is 11 bit Extended interface
8. **STmin**

   Indicates the time delay between transmission of two consecutive frames
9. **Block Size**

   Maximum number of consecutive frames that a sender can send before waiting for the flow control
10. **Flow Control Length**

Length of the flow control to be transmitted

11. **P2 Time Out**

    Indicates the time that the tool should wait for the ECU to respond

12. **P2 Extended**

    Indicates the time to wait after the Negative response received

13. **S3 Client**

    Indicates the time delay between tester present messages to be transmitted

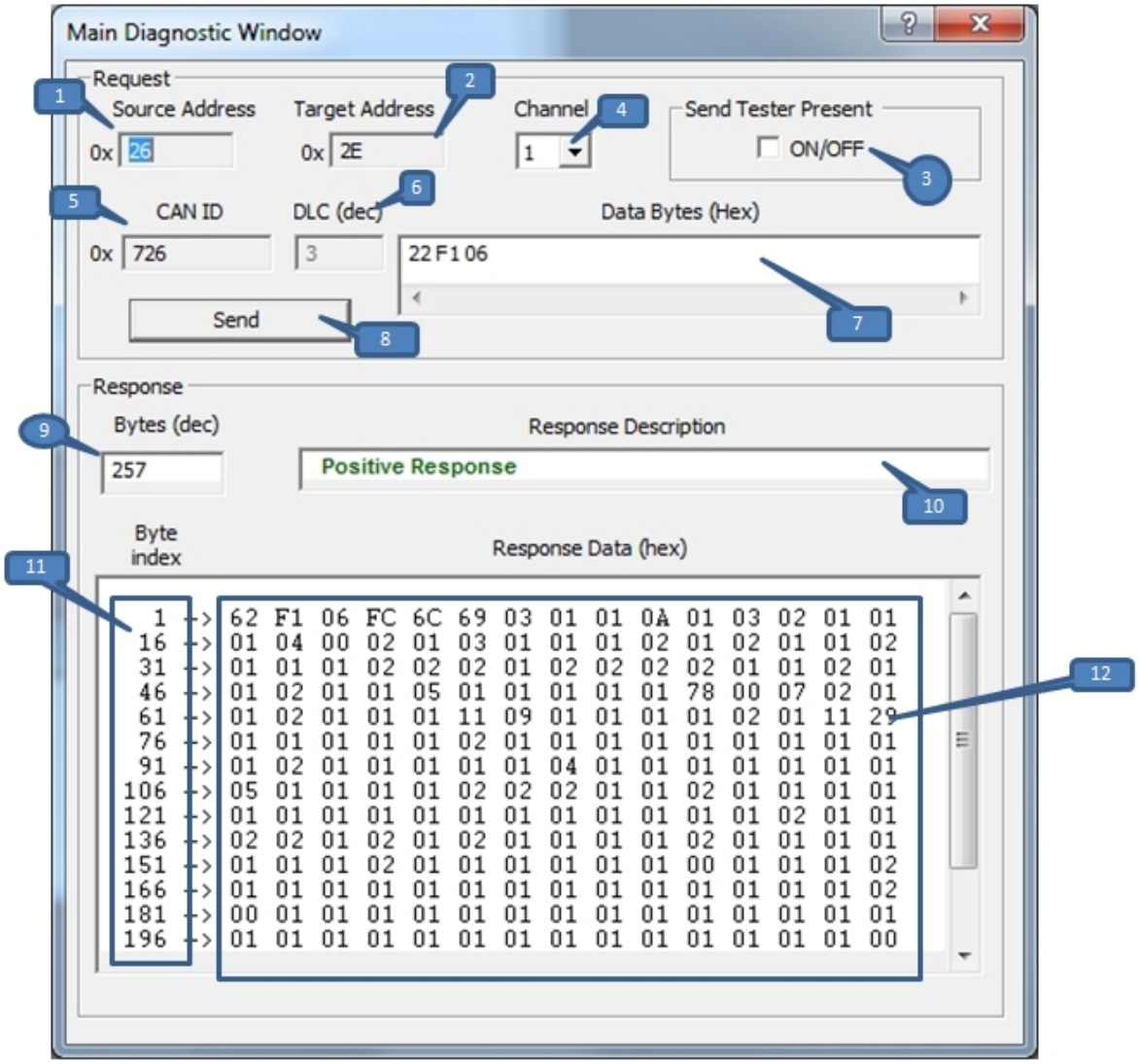
Diagnostics Main Window

Introduction:

Diagnostics Main Window is used to transmit diagnostics requests and to monitor the diagnostics responses received from the ECU

Configuration:

To configure diagnostic requests for transmission or to monitor diagnostic response use **CAN->Diagnostics->Main Window** menu.This will display the Window as shown below.



Displayed Fields:

1. **Source Address**

   To specify the Source Address if the interface is selected as 29 bit interface

If the interface is selected as 11 bit interface, the source address will be taken from **CAN ID Request** to ECU field in the **Settings** window

2. **Target Address**

   To specify the Target address if the interface is selected as 29 bit interface

   If the interface is selected as 11 bit interface, the source address will be taken from **CAN ID Response** from ECU field in the **Settings** window
3. **Send Tester Present**

   Checked to transmit tester present message
4. **Max DLC**

   If checked, the data length of the messages transmitted will be set to 8 bytes even if the data length of the message is less than 8 bytes
5. **Channel**

   Channel number on which the message to be transmitted
6. **CAN ID**

   Indicates the message identifier
7. **DLC**

   Displays the data length of the message based on the bytes inserted in the Data Bytes field
8. **Data Bytes**

   Data bytes to be transmitted
9. **Send**

   Transmits the configured message
10. **Bytes**

    Number of data bytes received as response to the request sent
11. **Response Description**

    Description of the response received
12. **Byte Index**

    Index or position of the data bytes
13. **Response Data**

    Data bytes received as response to the request sent

FlexRay

Introduction

FlexRay Simulation in BUSMASTER

Introduction:

BUSMASTER can be used to Transmit or Receive (Monitor) the FlexRay messages.The following steps are required to Configure the BUSMASTER for Transmit\Receive the FlexRay Messages.

1. Cluster Configuration:

To Transmit\Receive the FlexRay Messages a proper FIBEX File has to Imported in BUSMASTER.Refer **Cluster Configuration** Section for more Information.

2. Controller (Driver) Selection:

BUSMASTER can be connected to Physical FlexRay Network using FlexRay Controller.Refer **Controller Selection** section for more Information.

3. Connect to Network:

Once the Cluster & Controllers are properly configured BUSMASTER can be connected to Network using **FlexRay->Connect**. menu or the FlexRay Connect Tool bar Button as shown in following figure.

4. Transmit Messages:

FlexRay Messages Can be transmitted ovr FlexRay network using FlexRay Tx Window.Refer **FlexRay Transmission Window** Section for more information.

5. Monitoring Messages:

BUSMASTER Message Window can be used to monitor the FlexRay messages of FlexRay Network.Refer **FlexRay Message Window** section for more information.

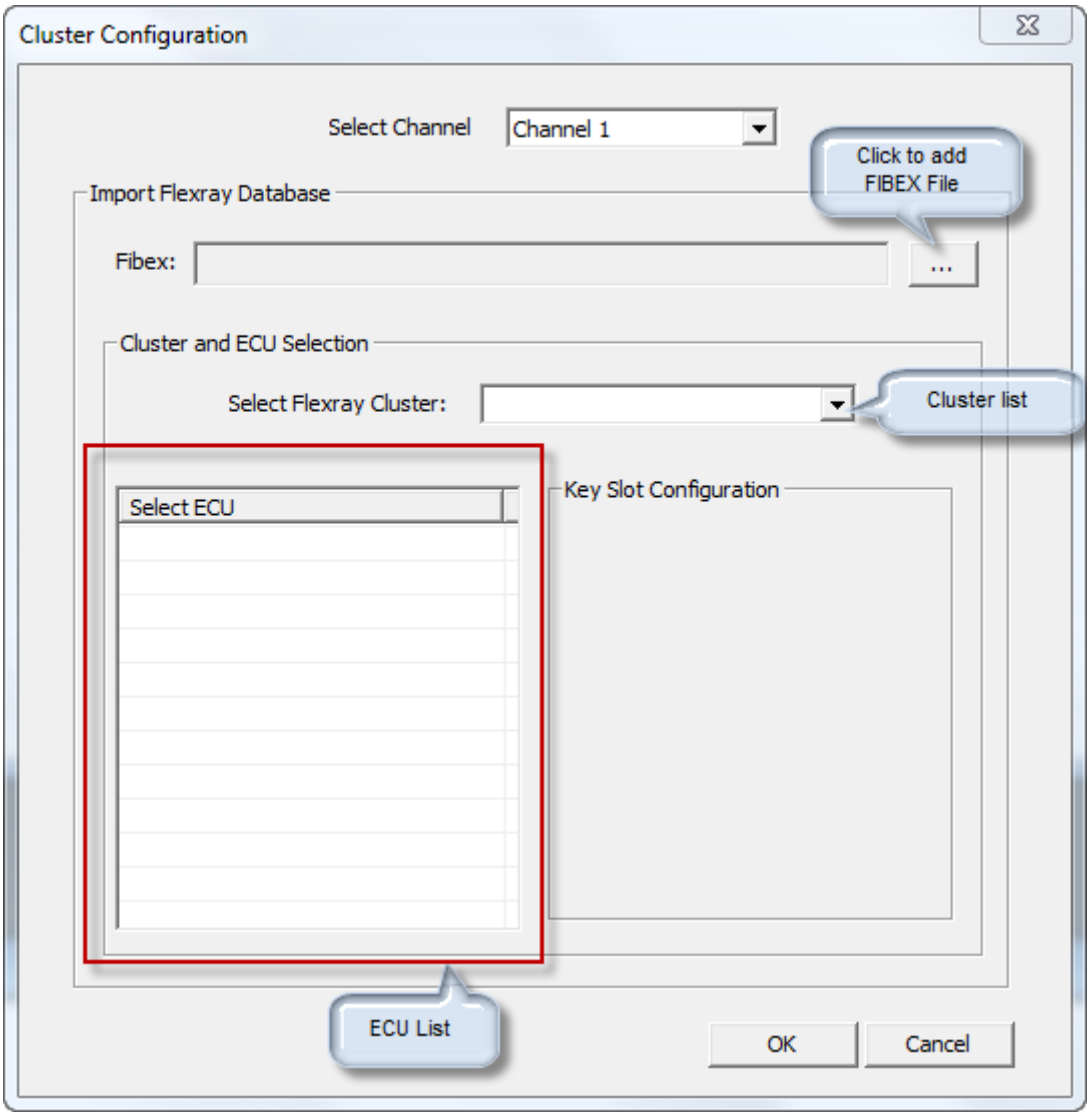
Cluster Configuration

Introduction:

To connect BUSMASTER to the FlexRay Network first it has to be configured with the proper FIBEX File.This can be done using **Cluster Configuration window**.

Configuration:

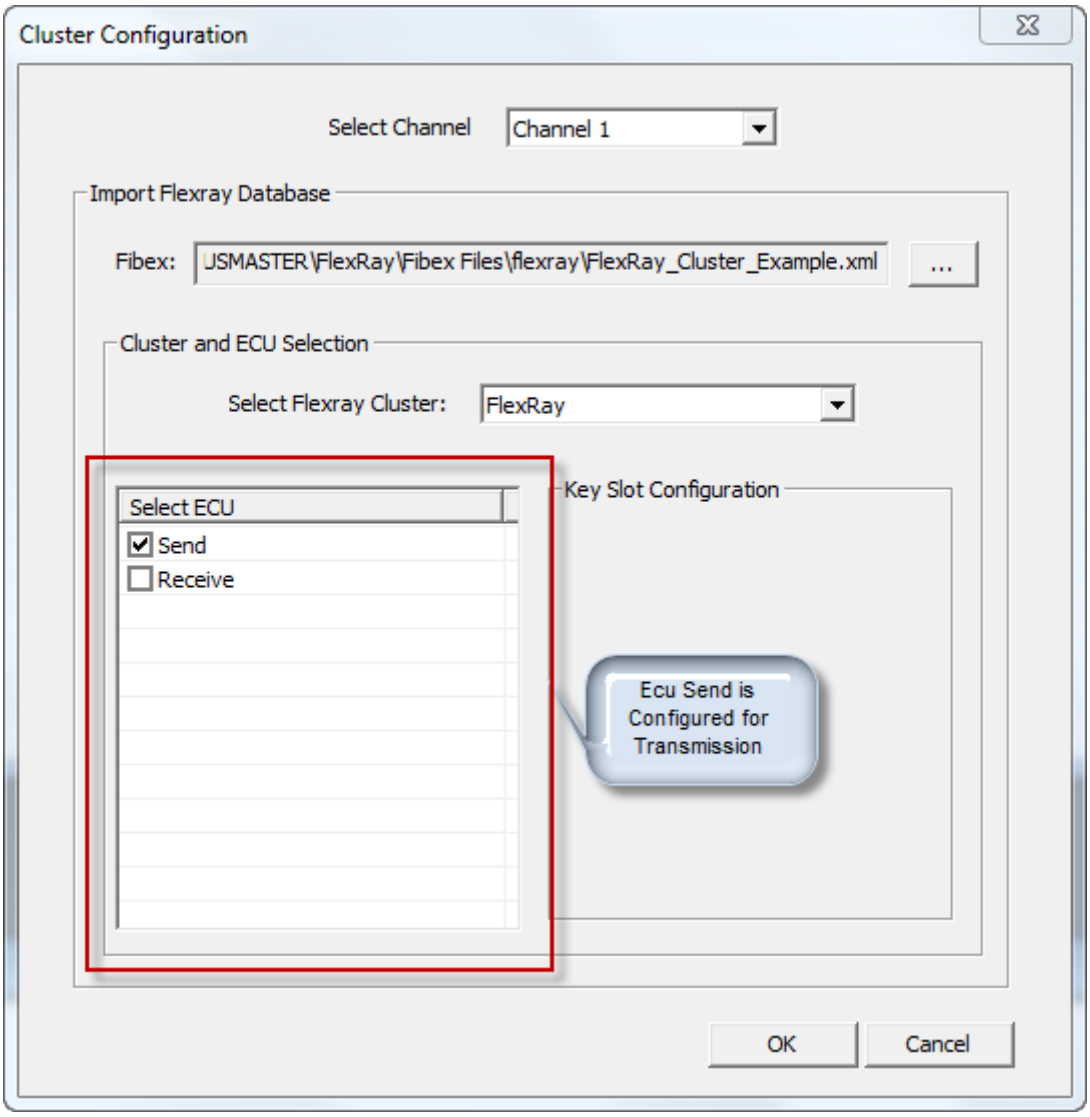
To configure the Cluster use **FlexRay->Cluster Configuration** menu.This will display the Window as shown in following Figure.



Adding FIBEX File:

Click the Browse button as shown in above figure to add the FIBEX File.Once the file is added the Window will display the Clusters available in **Select FlexRay Cluster** combo box. The **Select ECU** List Box will display all ECUs configured for the selected cluster.An Example Cluster Configuration is shown in following figure.

Current BUSMASTER Supports FIBEX Versions 2.0, 3.0, 4.0.



ECU **Send** is selected for Simulation in BUSMASTER.So all the Tx Message configured for **Send** ECU will be available for transmission in Tx Window.Check **FlexRay Transmission Window** Topic for more information on How to Transmit the FlexRay Messages over FlexRay Bus.

FlexRay Controller Configuration

Introduction:

BUSMASTER Can be connected to FlexRay physical channel using FlexRay Controller.

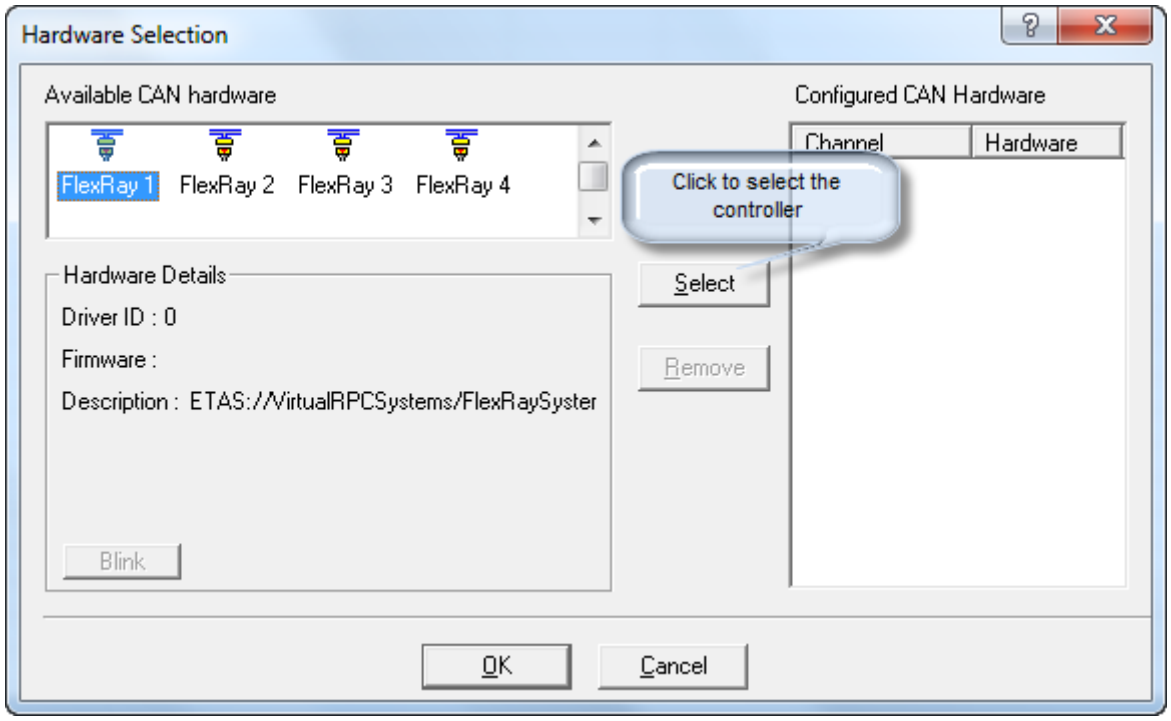
Currently BUSMASTER Supports the following FlexRay Controllers.

1. ETAS BOA Controllers.
2. GIGATRONIK flex-i Controller.

Selecting Controller:

Before Selecting the controlletr the BUSMASTER has to be configured with the proper FIBEX File.Refer **Cluster Configuration** for more information.

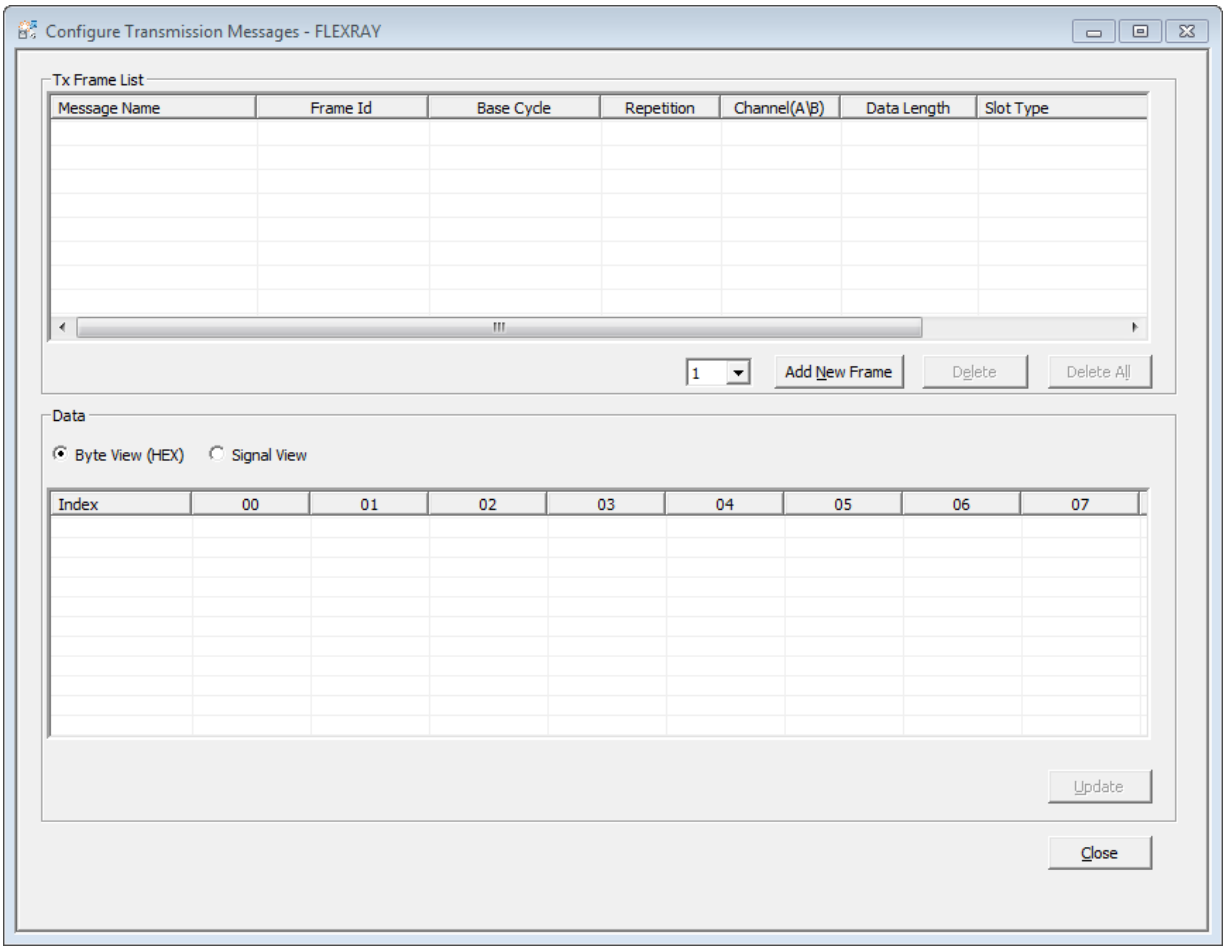
To select controller use FlexRay->Driver Selection->*{Driver}* For example to select ETAS BOA Driver use **FlexRay->Driver Selection->ETAS BOA.**If only one controller is connected to PC that controller will be selected automatically.Otherwise Hardware Selection window with all the available controllers will be displayed as shown in following figure.



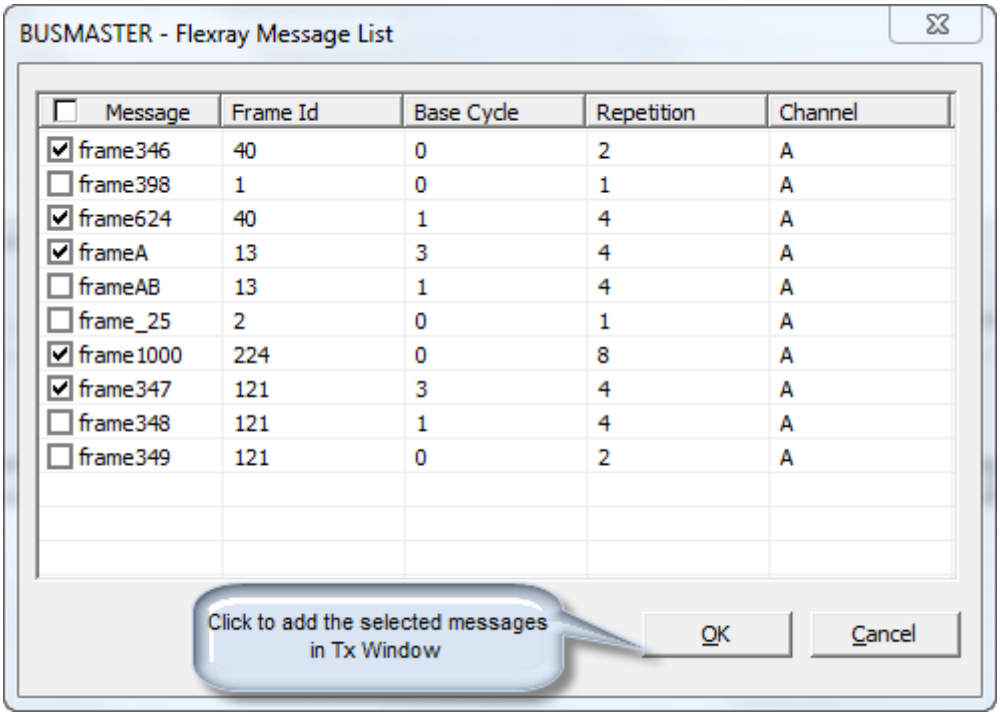
Once the Cluster & Controller is configured BUSMASTER Can be connected to FlexRay network using **FlexRay->Connect** Menu.If any Error occur during the initialisation of Controller the information will be displayed in BUSMASTER Trace Window.

Transmit Messages

FlexRay Transmit Window can be used to send FlexRay Messages over FlexRay bus using.Select **FlexRay->Transmit->Configure** menu option.This Will Display\Hide the FlexRay Tx Window as shown in figure below.

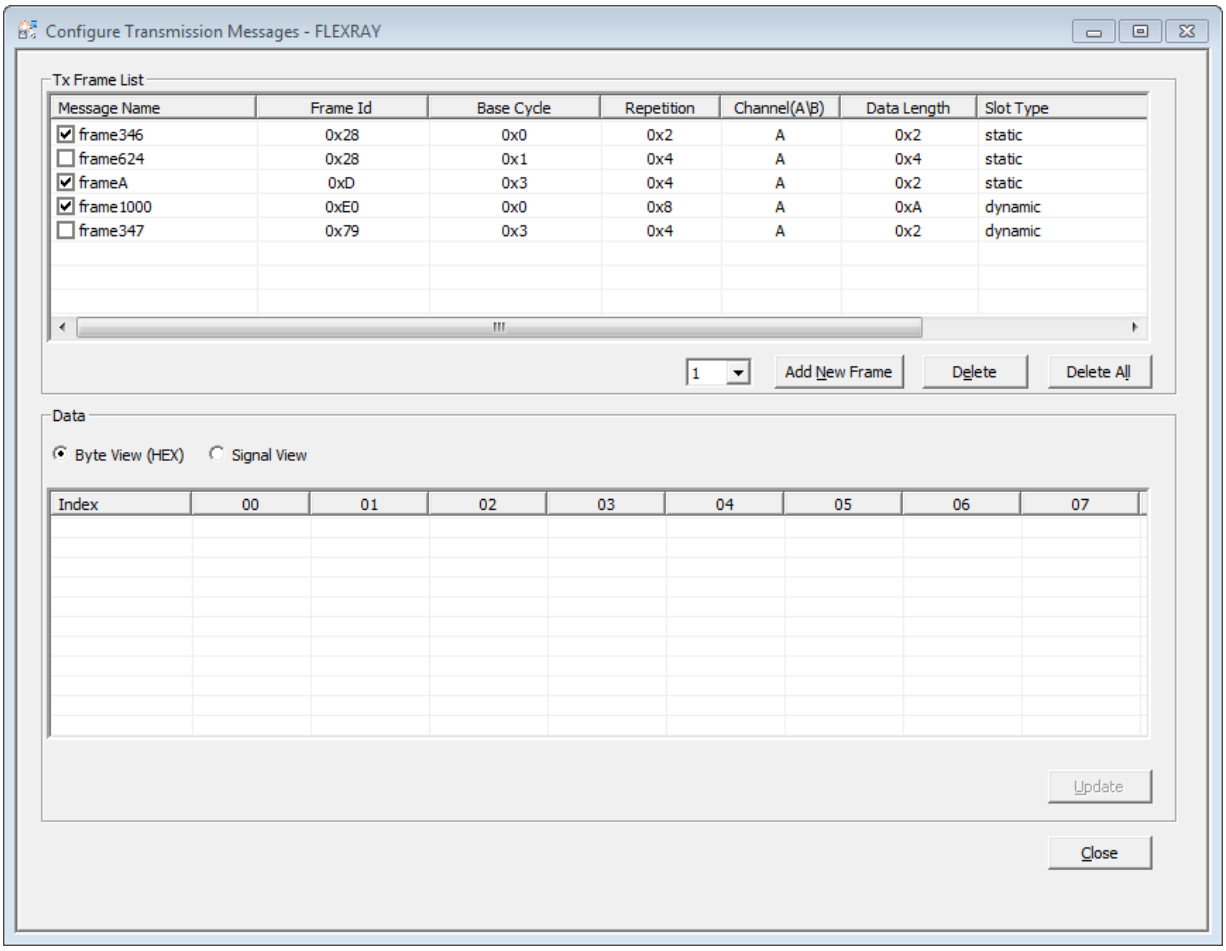


To Add messages Use **Add New Frame** button.This Will display a window, as shown below, containing all the Tx Messages of Selected ECU's. To add the messages in Transmit Window select the message using check box click on the **OK** Button.



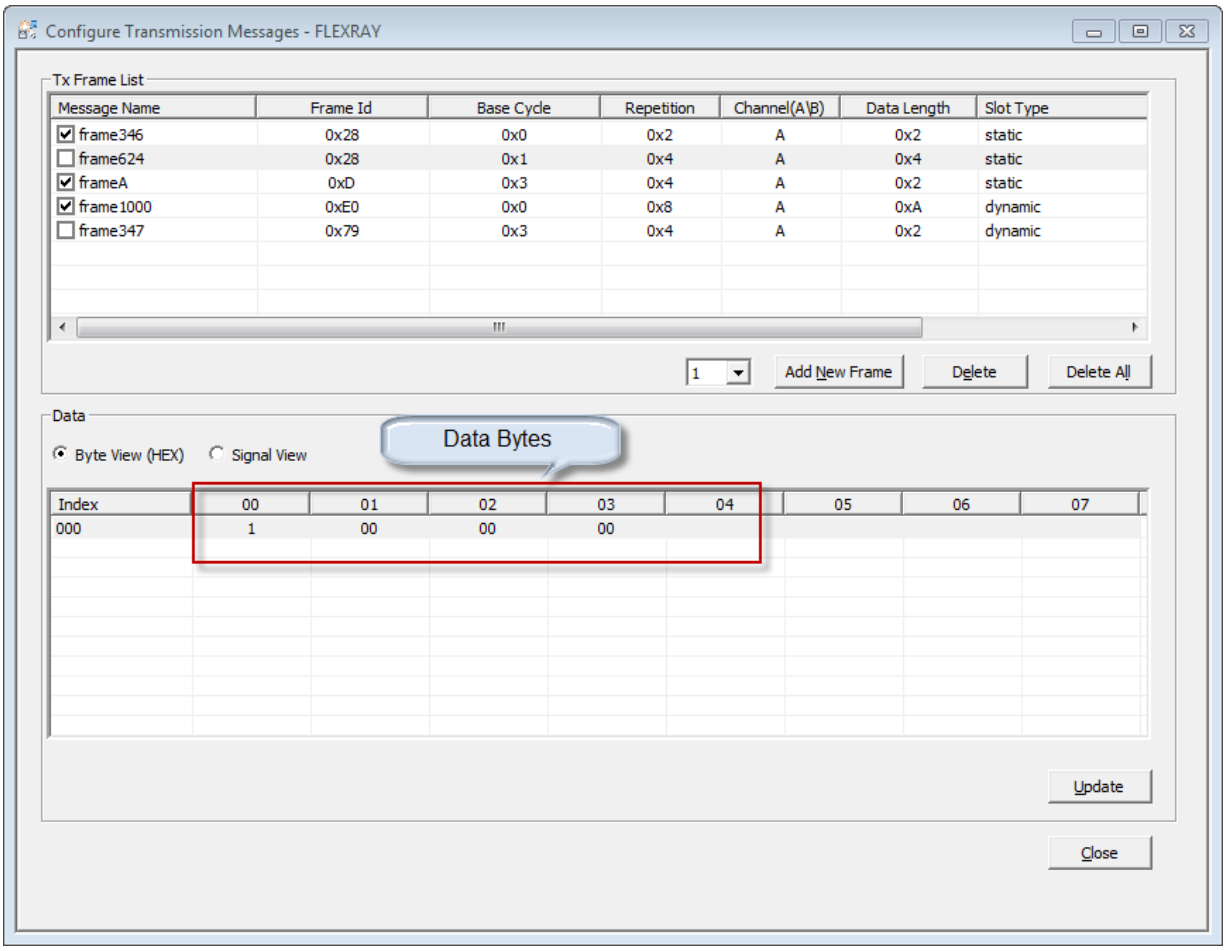
Transmitting Message Over FlexRay BUS:

After Configuring the messages they will be displayed in Transmit Window as shown in below figure.Click on the check box beside a message to select the message for transmission. Once the BUSMASTER Connected to the FlexRay network all the selected message will be sent on the network in their schedule time.



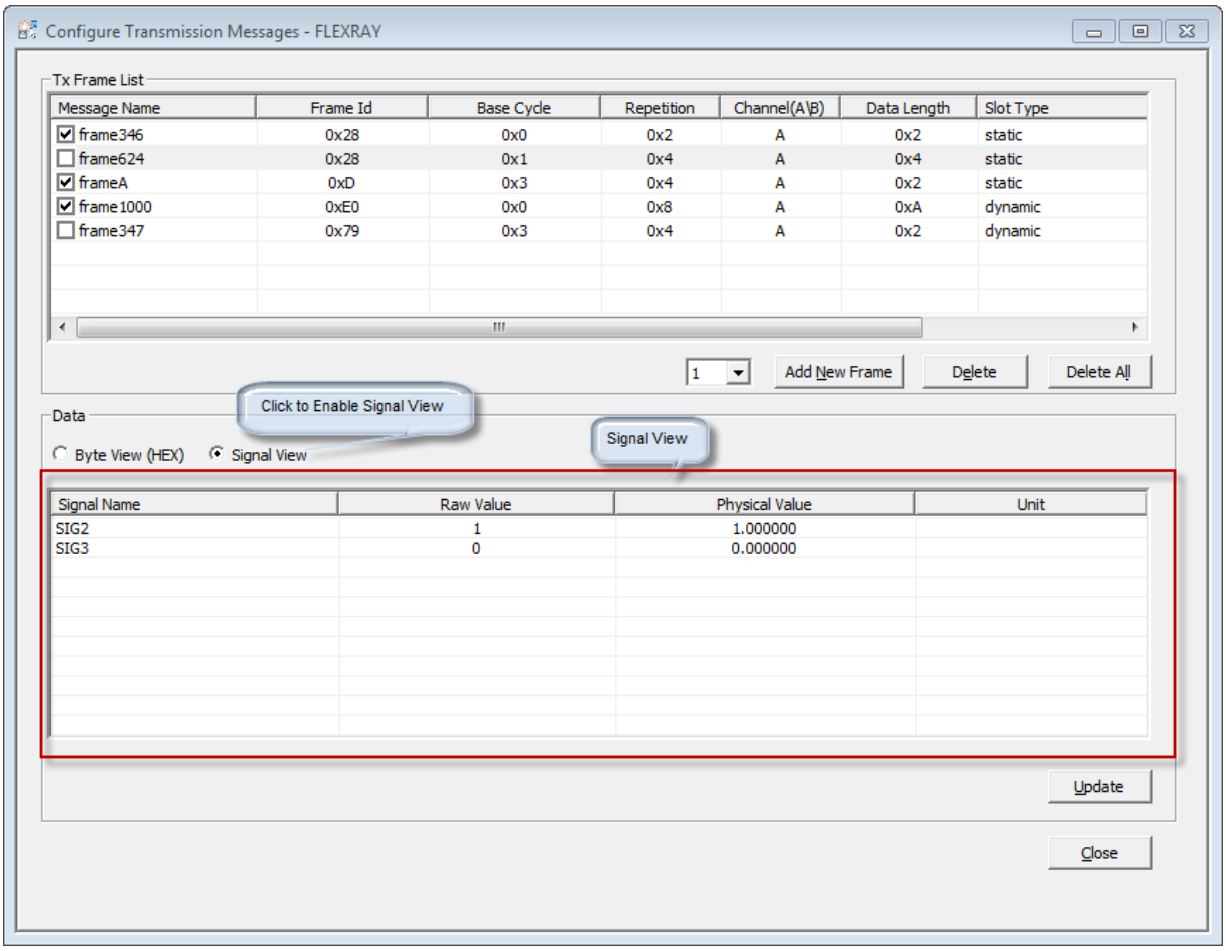
Updating Data Bytes:

To Change the Data bytes of a message click on the message.This will display the current data bytes of the Message. in Data Window as shown in below image.To change the Data bytes double click on the required data byte.Use Tab or Arrow Keys to move to the next data bytes.Click on Update button to Apply the changes.



Signal View:

To View the Signals of a any Frame click on it and select the Signal View.This will display the signals & their Raw\Physical values as shown in below.



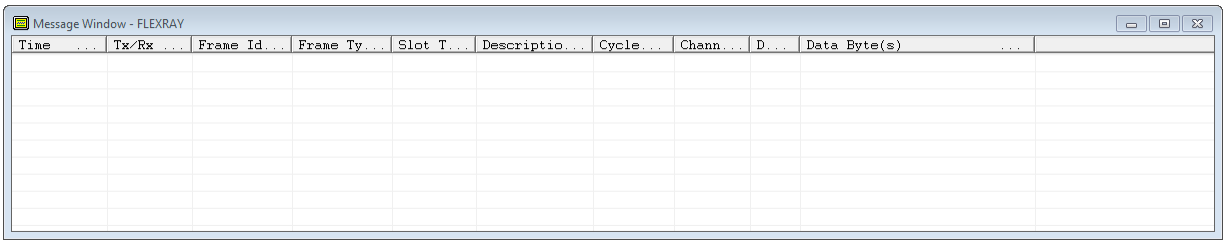
FlexRay Message Window

Introduction:

On-line FlexRay Network Monitoring can be done using FlexRay Message window.

Activation:

Use **FlexRay->Message Window->Activate** menu to Activate the Message window.This will display Message Window as shown in following figure.

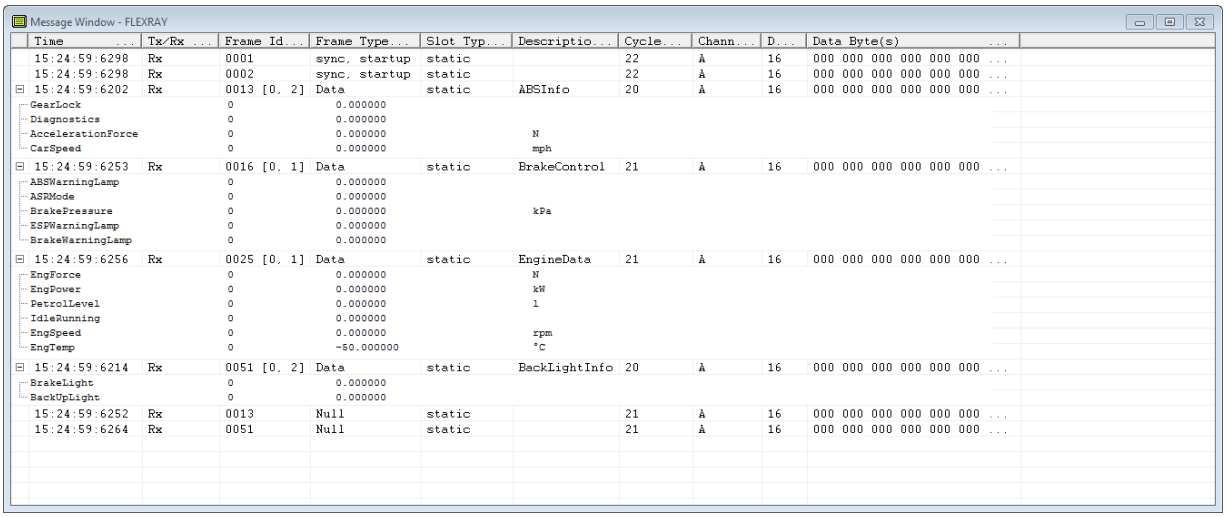


Once the BUSMASTER is connected to FlexRay Network the Message window will display all the Messages Transmitted on the network.The Messages can also display the message interpretation.

Enabling Interpretation:

To enable the interpretation the Message window should be in overwrite mode.Use **FlexRay->Message Window->Overwrite**. menu to enable the overwrite mode.After this use **FlexRay->Message Window->Interpret.**

The below figure shows Message window when it BUSMASTER is connected to FlexRay Network.


Message Window - FLEXRAY
Time
Tx/Rx
Frame Id...
Frame Type...
Slot Typ...
Descriptio...
Cycle...
Chann...
D...
Data Byte(s)
15:24:59:6298 Rx 0001 sync, startup static 22 A 16 000 000 000 000 000 000 ...
15:24:59:6298 Rx 0002 sync, startup static 22 A 16 000 000 000 000 000 000 ...
15:24:59:6202 Rx 0013 [0, 2] Data static ABSInfo 20 A 16 000 000 000 000 000 000 ...
GearLock 0 0.000000
Diagnostics 0 0.000000
AccelerationForce 0 0.000000 N
CarSpeed 0 0.000000 mph
15:24:59:6253 Rx 0016 [0, 1] Data static BrakeControl 21 A 16 000 000 000 000 000 000 ...
ABSWarningLamp 0 0.000000
ASRMode 0 0.000000
BrakePressure 0 0.000000 kPa
ESPWarningLamp 0 0.000000
BrakeWarningLamp 0 0.000000
15:24:59:6256 Rx 0025 [0, 1] Data static EngineData 21 A 16 000 000 000 000 000 000 ...
EngForce 0 0.000000 N
EngPower 0 0.000000 kW
PetrolLevel 0 0.000000 l
IdleRunning 0 0.000000
EngSpeed 0 0.000000 rpm
EngTemp 0 -50.000000 °C
15:24:59:6214 Rx 0051 [0, 2] Data static BackLightInfo 20 A 16 000 000 000 000 000 000 ...
BrakeLight 0 0.000000
BackUpLight 0 0.000000
15:24:59:6252 Rx 0013 Null static 21 A 16 000 000 000 000 000 000 ...
15:24:59:6264 Rx 0051 Null static 21 A 16 000 000 000 000 000 000 ...

The Following section will explain the Columns Displayed in Message window with explanation.

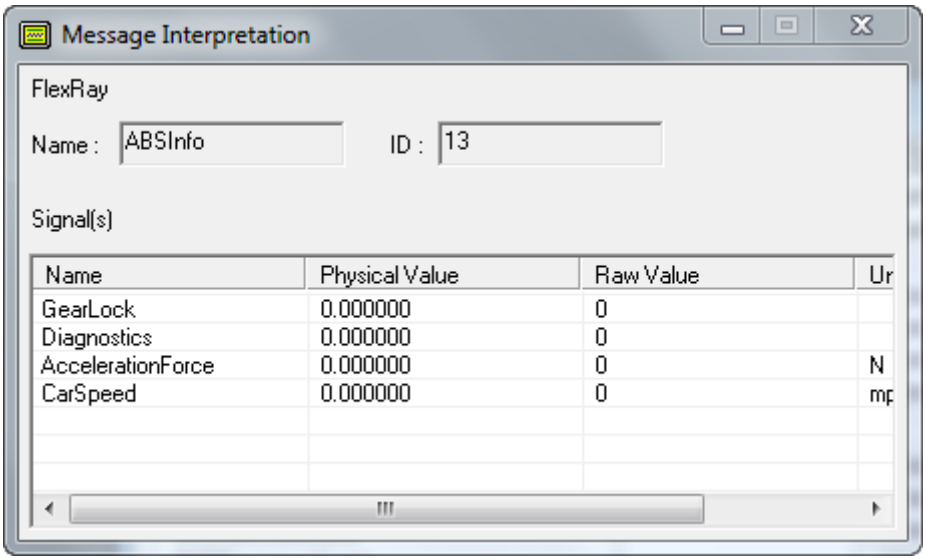
Table 1:

Column	Explanation
Time	This Will display the time at which message is received\Sent on FlexRay BUS.The time mode can be changed to Absolute\System\Relative Mode using **FlexRay->Message Window->Time Mode** menu
Tx/Rx	This Menu will display weather the message is received or sent from BUSMASTER.Tx Represents the message is sent From BUSMASTER.Rx Represent Message is received in BUSMASTER
Frame Id	This Column gives the information about the Scheduling of Message.The information will be displayed in the format of ***slot_id [base_cycle, repetition]*.**
Frame Type	This Column will tell the Frame type.The following are the Frame types displayed in this column. • sync • startup • sync, startup • Null • Data
Slot Type	This column will tell weather the message is Transmitted\Received in static\Dynamic Slot.
Description	This column will give the Message Name associated with the ID.
Cycle	This column will display the Cycle in which the message was received
Channel	**:**This column will display on which channel (A, B or AB) the message was received.
DLC	This column will display the Length of Frame in Bytes.

Column	Explanation
Data Byte (s)	This column will display the Data Bytes received\Transmitted of the Frame

Message Interpretation window:

It is possible to Monitor the interpretation of a single message in separate window called **Message Interpretation.**Double click on any message in Message window to Activate the Message Interpretation window.An Instance of this window is shown in following figure.



LIN

Introduction

LIN Simulation in BUSMASTER

Introduction:

BUSMASTER can be used as master to transmit master requests and as slave to respond to master requests. User can monitor/analyze the LIN messages using BUSMASTER.The following steps are required to Configure the BUSMASTER for transmission of frame headers or transmission/reception of LIN messages.

1. Cluster Configuration:

1. To Transmit\Receive the LIN Messages BUSMASTER has to be configured with LIN Baud Rate and Version.Refer **Cluster Configuration** Section for more Information.
2. To enable master mode for LIN channel for transmitting frame headers, check the **Enable Master Mode** check box under **LIN Network Settings**

2. Schedule Table Configuration:

Configure Schedule Table window can be used to select schedule table/frame headers for transmission imported from the loaded LDF file if BUSMASTER is used as master. Refer LIN ScheduleTable Configuration for more information.

3. Controller (Driver) Selection:

BUSMASTER can be connected to Physical LIN Network using LIN Controller.Refer **Controller Selection** section for more Information.

4. Transmit Messages:

LIN Slave Messages or LIN Master requests Can be transmitted over LIN network using LIN Tx Window.Refer **LIN Transmission Window** Section for more information.

5. Connect to Network:

Once the Cluster & Controllers are properly configured BUSMASTER can be connected to Network using **LIN->Connect**. menu or the LIN Connect Tool bar Button as shown in following figure.

5. Monitoring Messages:

BUSMASTER Message Window can be used to monitor the LIN messages of LIN Network.Refer **LIN Message Window** section for more information.

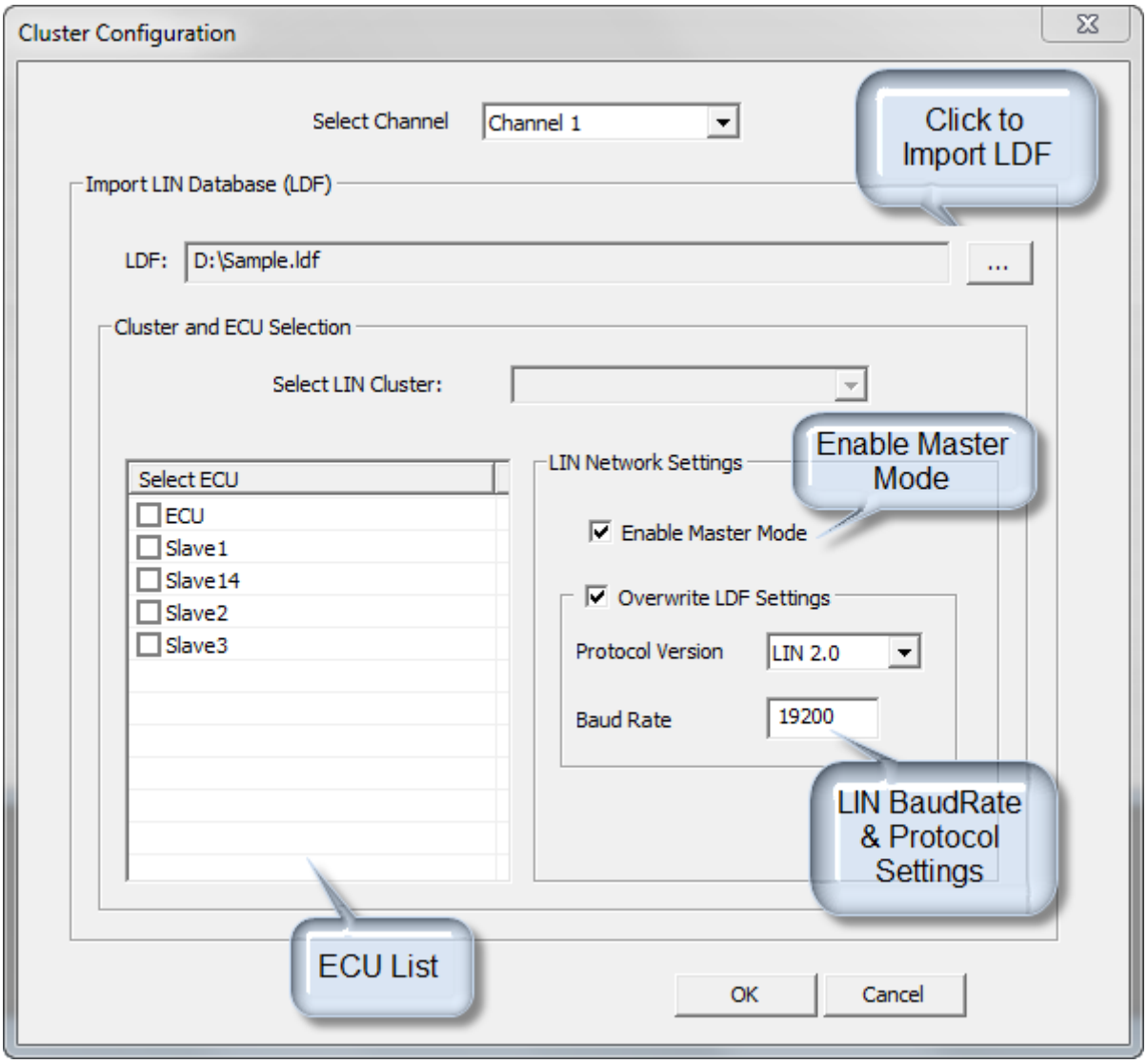
LIN Cluster Configuration

Introduction:

To connect BUSMASTER to the LIN Network first it has to be configured with the proper LIN Baud Rate and LIN Protocol Version.This can be done using by importing a LDF or using manual settings.

Configuration:

To configure the Cluster use **LIN->Cluster Configuration** menu.This will display the Window as shown in following Figure.

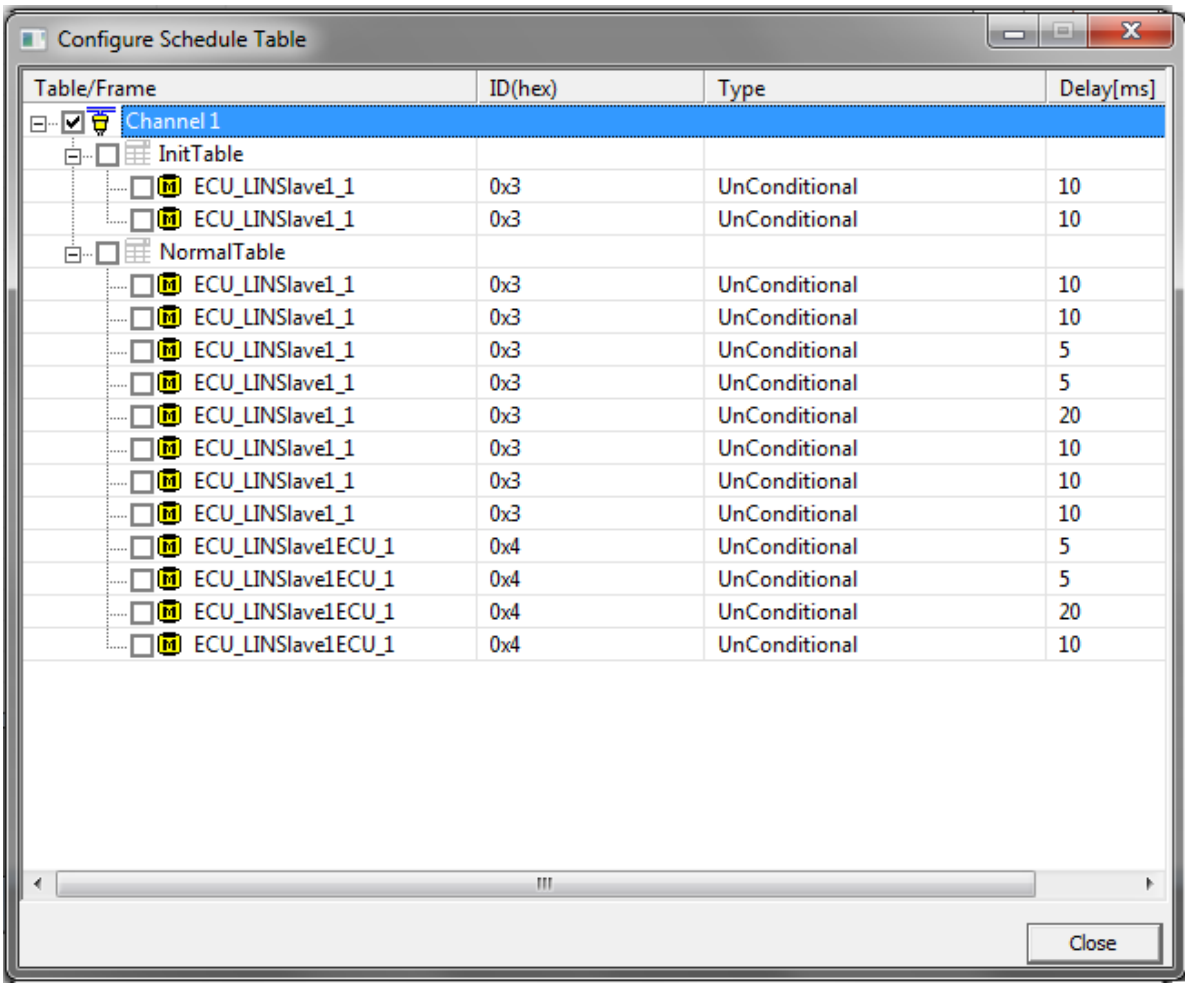


1. To enable master mode for LIN channel for transmitting frame headers, check the **Enable Master Mode** check box under **LIN Network Settings**
2. LIN baud rate & Protocol version can be set either by loading the LDF file or can be set explicity by using **LIN Network Settings** section by Enabling **Overwrite LDF Settings** as shown in above figure.

LIN Schedule Table Configuration

LIN Schedule Table Configuration can be used to configure schedule tables imported from LDF file to transmit master requests by following the below steps.

1. To configure Schedule Table use **LIN->Schedule Configuration** menu which displays **Configure Schedule Table** dialog as shown below.



2. Configure Schedule Table window displays the Schedule Tables channel wise.
3. Frames will be listed under respective Schedule table.

Displayed Columns

- **Table/Frame**

  Schedule Table name or Frame name
- **ID(hex)**

  Frame Identifier displayed in hex mode
- **Type**

  Frame type or Command name
- **Delay**

  Frame delay time in ms

4. To select the Schedule Table from the list, mark the respective Schedule Table as checked. By which all the frames part of Schedule Table will be selected
5. User can select/de-select the frame(s) by marking the frame as check/un-check.
6. Master request(s) shall be sent only for the selected frame(s) at pre-configured time interval as specified in the Schedule table.
7. Schedule Tables and Frames can be selected/de-selected during runtime.
8. The check status of Schedule Table and the frames will be stored in the configuration file and retained on importing configuration file.

Note:

- Schedule Tables and frames from the **Configure Schedule Table** window will be considered when BUSMASTER simulates the LIN Master node of a LIN network

- From the LDF file imported, only unconditional frames in the Schedule Table will be considered for the configuration and execution.

LIN Controller Configuration

Introduction:

BUSMASTER Can be connected to LIN physical channel using LIN Controller.

Currently BUSMASTER Supports the following LIN Controllers.

1. ETAS BOA (To monitor messages associating LDF file is required for LIN ETAS BOA)
2. ETAS ISOLAR-EVE
3. PEAK USB
4. Vector XL
5. Kvaser LIN

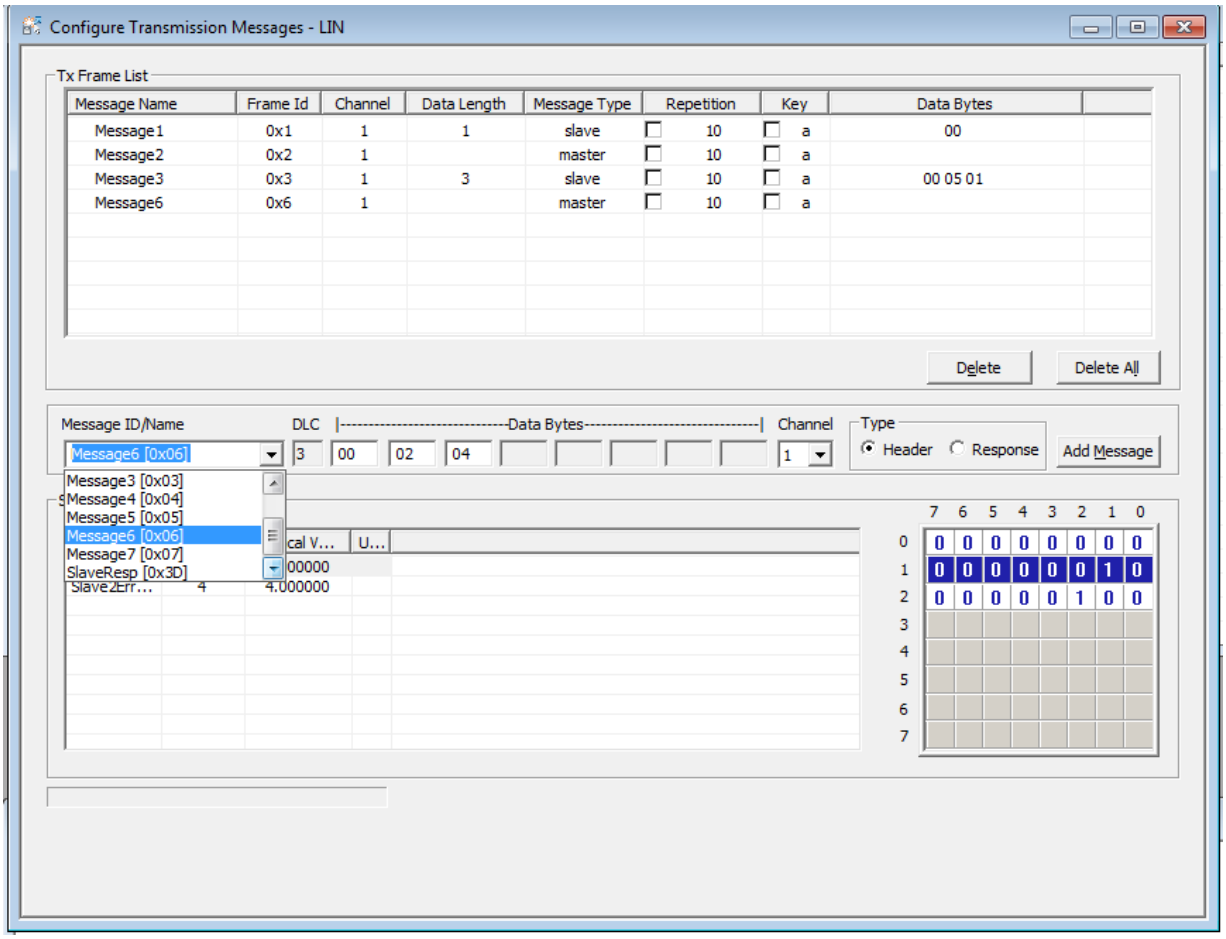
Selecting Controller:

To select controller use LIN->Driver Selection->*{Driver}* For example to select ETAS ISOLAR EVE Driver use **LIN->Driver Selection->ETAS ISOLAR-EVE.**

Once the Controller is configured BUSMASTER Can be connected to LIN network using **LIN->Connect** Menu.

Transmit Messages

Master can transmit frame headers and Slave can respond to the Master requests over LIN-bus using LIN Transmit Window. Use **LIN --> Transmit --> Configure** menu option, to open the LIN Transmission Window.



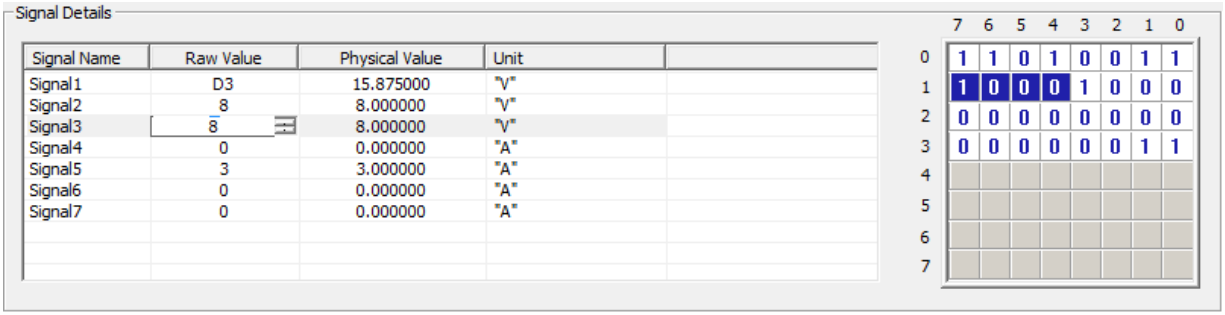
Once a LDF File is imported the Messages(DB Messages) in LDF file will be populated in **Message ID/Name** List Box as shown in above figure.It is also possible to add Non-db Messages by typing Message id in List Box. Once the Message is selected in List Box, Click on **Add Message** Button to add it in **Tx Frame List**.

Configure Master Requests:

- Select the frame type as **Header** from the Type group
- Dlc and data byte values will not be editable for frame Header

Configure Slave Responses:

- Select the frame type as **Response** from the Type group
- The DLC and data byte values can be changed using DLC and Data Bytes edit box windows.
- If the Message is a DB Messages and if it has signals associated, then they will be displayed in Signal List as shown in following figure.The Raw\Physical value of the signal can be changed by double clicking the corresponding cell.



Cyclic Transmission of Message:

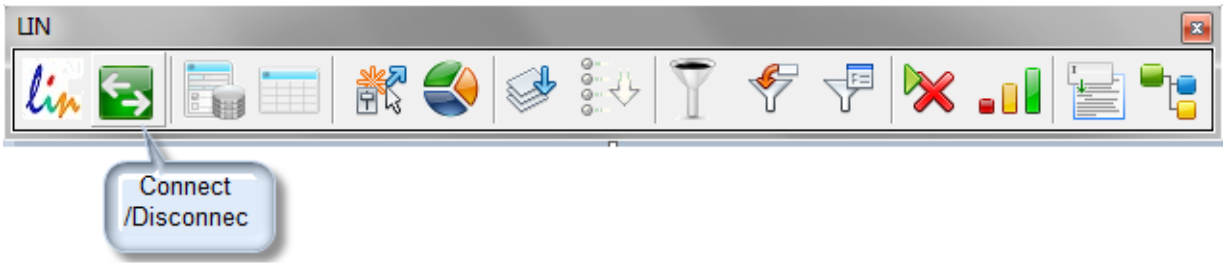
The message/frame header can be transmitted periodically by Enabling Repetition.Cyclic Transmission will be useful to transmit the message with different data bytes periodically.

Transmission on Event:

The Message/frame header can be sent to the controller on pressing key.Each message in Tx Frame List can be assigned an alpha-numeric key.

Connect and Disconnect

User can connect/disconnect the tool from the LIN-bus by pressing/releasing a toggle tool bar button shown in the figure below.



The tool can also be connected by selecting **LIN** > **Connect** menu option (available only in disconnected state). The same can be disconnected by selecting **LIN** > **Disconnect** menu option (available only in Connected state) or by pressing Esc key. When the tool is in connected state, the menu option will become Disconnect and when the tool is in disconnected state, the menu option will be displayed is Connect.

Transmission and reception of messages can be done only when the tool is in the connected state.

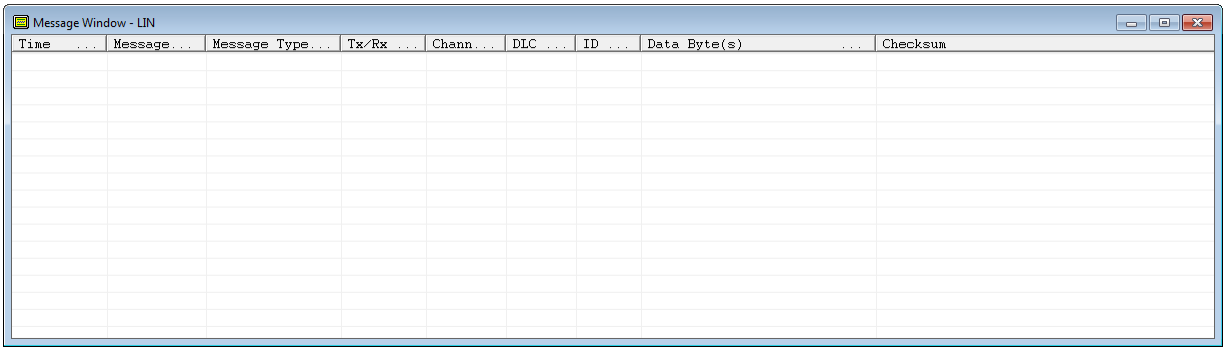
LIN Message Window

Introduction:

On-line LIN Network Monitoring can be done using FlexRay Message window.

Activation:

Use **LIN->Message Window->Activate** menu to Activate the Message window.This will display Message Window as shown in following figure.



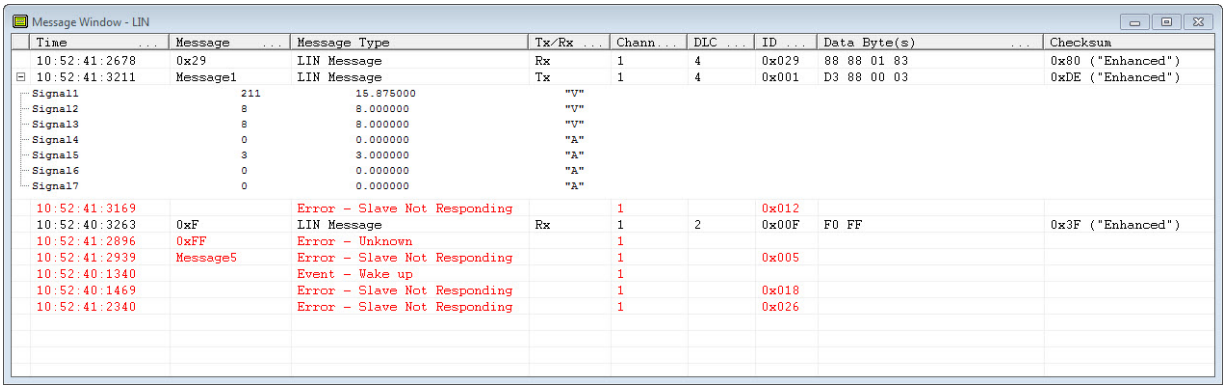
Once the BUSMASTER is connected to LIN Network the Message window will display all the Messages Transmitted on the network.Also the Message window will display the LIN Error Messages & other LIN Events.Currently the following Error or Event messages were supported.

- CRC Error
- Sync Error
- Slave Not Responding Error
- Sleep Event

Enabling Interpretation:

The Signal values of LIN Messages can be analysed using Interpretation mode.To enable the interpretation the Message window should be in overwrite mode.Use **LIN->Message Window->Overwrite**. menu to enable the overwrite mode.After this use **LIN->Message Window->Interpret.**

The below figure shows Message window when it BUSMASTER is connected to LIN Network.


Message Window - LIN
Time Message Message Type Tx/Rx Chann DLC ID Data Byte(s) Checksum
10:52:41:2678 0x29 LIN Message Rx 1 4 0x029 88 88 01 83 0x80 ("Enhanced")
10:52:41:3211 Message1 LIN Message Tx 1 4 0x001 D3 88 00 03 0xDE ("Enhanced")
Signal1 211 15.875000 "V"
Signal2 8 8.000000 "V"
Signal3 8 8.000000 "V"
Signal4 0 0.000000 "A"
Signal5 3 3.000000 "A"
Signal6 0 0.000000 "A"
Signal7 0 0.000000 "A"
10:52:41:3169 Error - Slave Not Responding 1 0x012
10:52:40:3263 0xF LIN Message Rx 1 2 0x00F F0 FF 0x3F ("Enhanced")
10:52:41:2896 0xFF Error - Unknown 1
10:52:41:2939 Message5 Error - Slave Not Responding 1 0x005
10:52:40:1340 Event - Wake up 1
10:52:40:1469 Error - Slave Not Responding 1 0x018
10:52:41:2340 Error - Slave Not Responding 1 0x026

The Following section will explain the Columns Displayed in Message window with explanation.

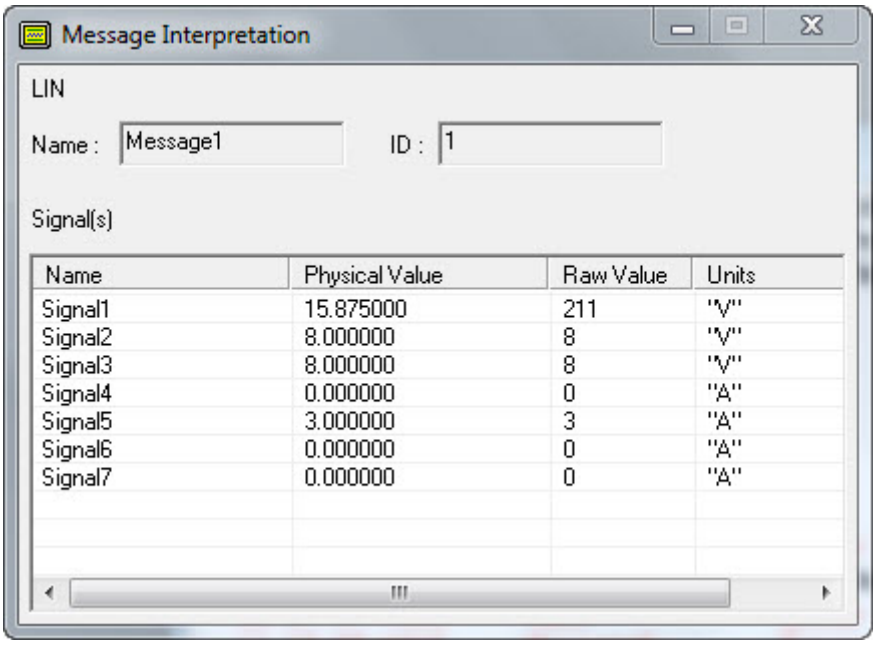
Table 2:

Column	Explanation
Time	This Will display the time at which message is received\Sent on LIN BUS.The time mode can

Column	Explanation
	be changed to Absolute\System\Relative Mode using **LIN->Message Window->Time Mode** menu
Tx/Rx	This Menu will display weather the message is received or sent from BUSMASTER.Tx Represents the message is sent From BUSMASTER.Rx Represent Message is received in BUSMASTER
Message	Displays the Name of message if available in LDF file
Message Type	This Column will tell the Frame type.The following are the Frame types displayed in this column. • LIN Frame • Error - Slave No Response • Error - CRC Error • Event - Sleep • Event - Wakeup
ID	Displays the LIN Message ID.
Checksum	This column will give the Checksum value and Checksum type.
Channel	This column will display on which channel (A, B or AB) the message was received.
DLC	This column will display the Length of Frame in Bytes.
Data Byte (s)	This column will display the Data Bytes received\Transmitted of the Frame

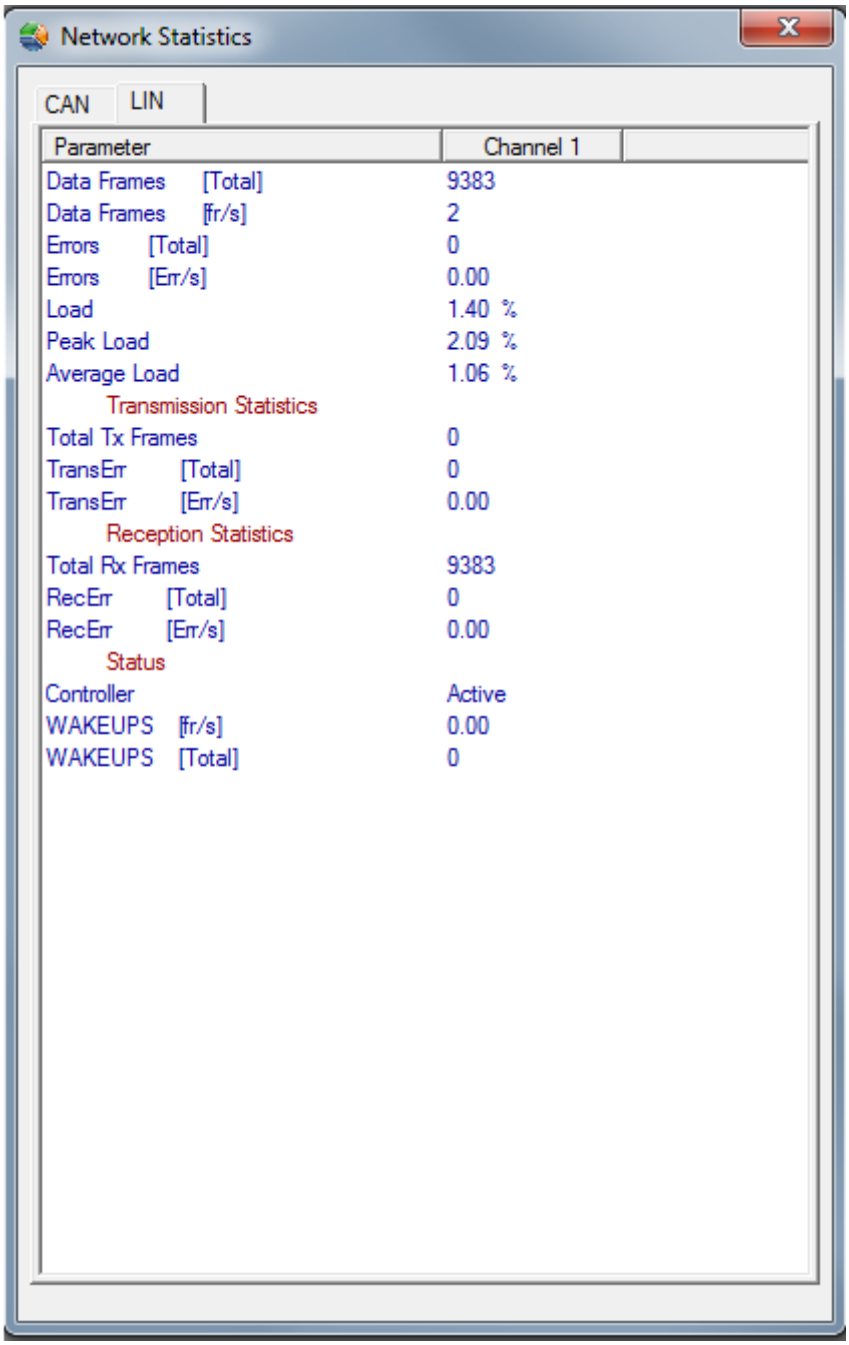
Message Interpretation window:

It is possible to Monitor the interpretation of a single message in separate window called **Message Interpretation.**Double click on any message in Message window to Activate the Message Interpretation window.An Instance of this window is shown in following figure.



Network Statistics

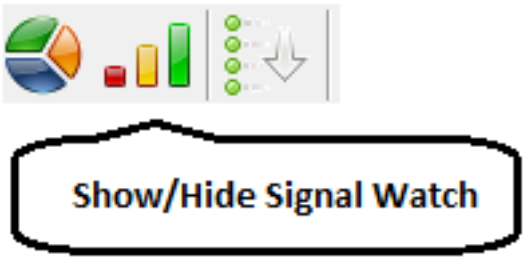
Network statistics dialog gives details about the messages transmitted and received on the bus. This information includes the number of Data Frames and Error messages transmitted and received by BUSMASTER and current rate of these parameters. Also information related to the total Wakeups and its rate will be displayed. This is updated once in a second. Message rate per second and Network load in terms of Bus traffic is also presented. The peak network load will show the peak traffic during that session. This information can be used to find bus utilisation. Statistics information will be cleared during connect and during controller reset.



To invoke Network Statistics Dialog, select the menu **Window --> Network Statistics**.

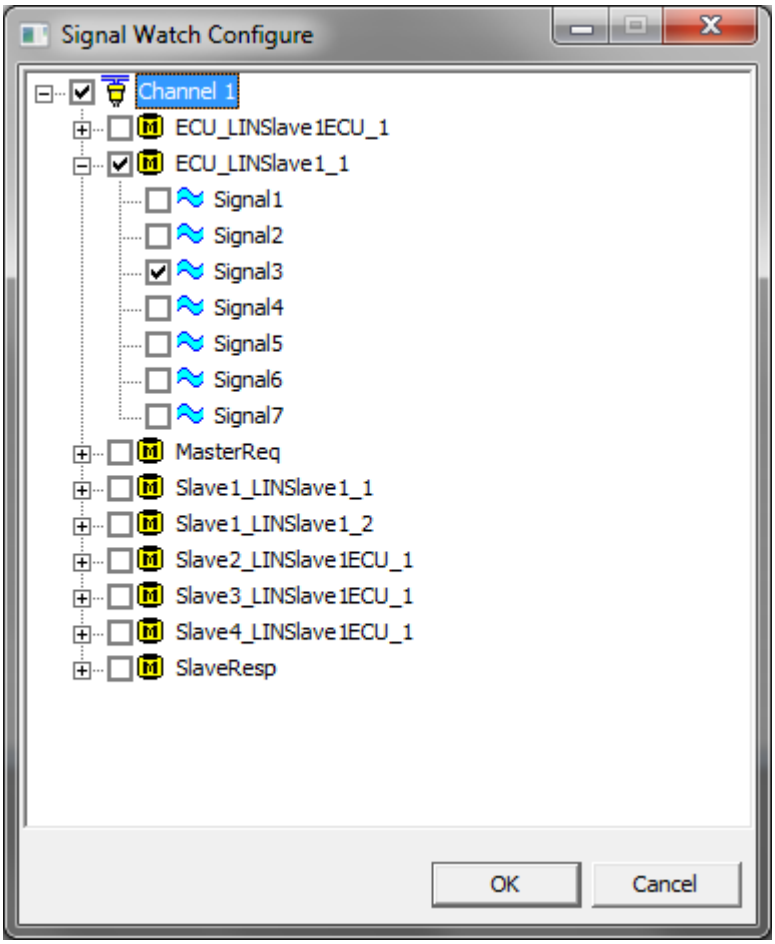
Signal Watch

User can watch the value of a signal using the signal watch window as and when a message having that signal is received. The Physical and Raw values will be listed and updated as and when the message arrives. Click on the tool bar button shown below to display the signal watch window.



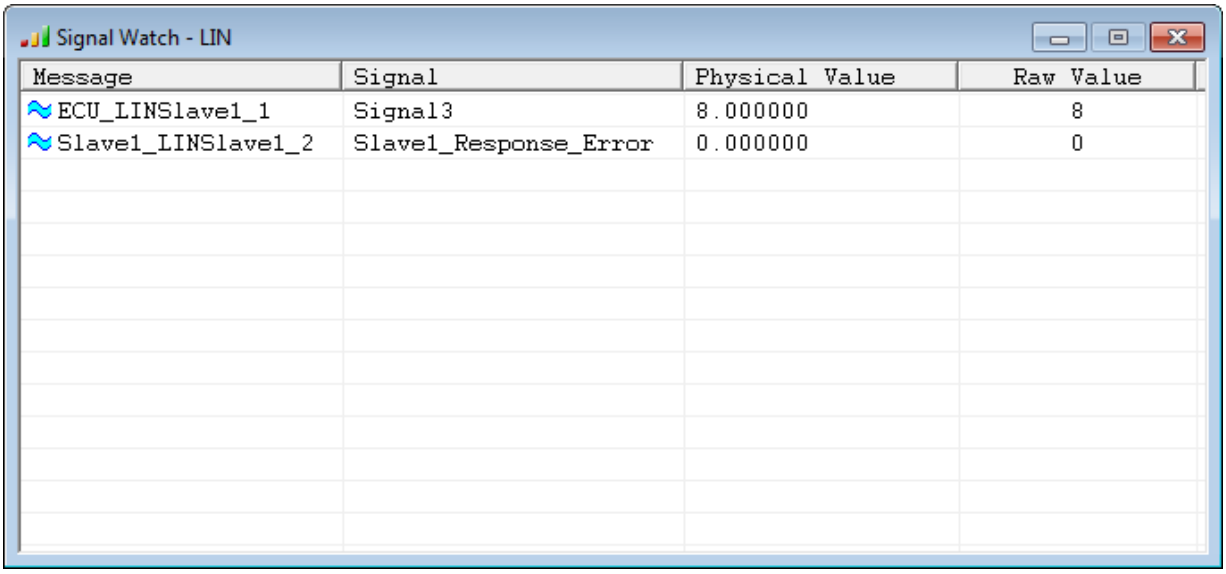
Add/ Delete Signals

Signal watch list can be interactively populated. The following list describes the steps to Add/Delete signals.

- Click on **LIN --> Signal Watch --> Activate**.
- A dialog box will be displayed then do right click and select Configure Signals from the menu. This will show the signal configuration Window.
- 

- Select a message and select associated signal from the Signal list. Check the signals to move the selected signal in to Watch List. Multiple signals can be checked. All signals belonging to a message can be added in to the watch list by checking the message check-box.
- Signal from the Watch List can be deleted by unchecking the entry.
- Signal Watch List can be cleared by selecting Delete All button.
- Changes will be saved and applied on selection of Ok. Cancel will ignore the changes.
- The Signal Watch List will be saved in the configuration file and will be reloaded during the load of that configuration file.

Show Signal Watch Window



After receiving a message BUSMASTER will update the signal watch window if the signals of received message are included in the signal watch list. The signal watch list will show Raw and Physical value of the signal with the Unit along with Message and Signal name.

Close signal watch window

User can directly close the window by clicking on Close [X] button.

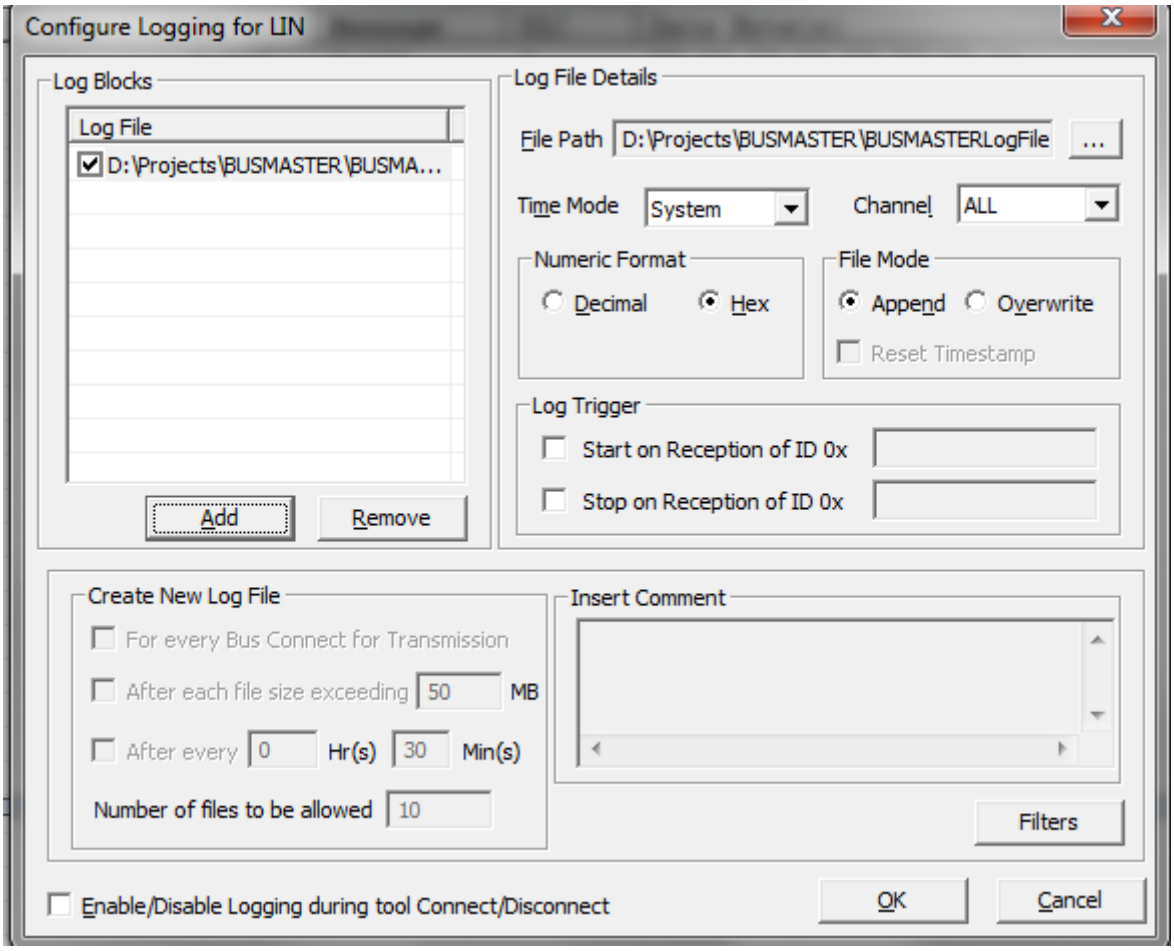
OR

1. Click on the drop-down button associated with the tool bar button shown above. This will pop-up a menu.
2. Click on Close menu option to close the signal watch window.

Logging

Logging

User can configure log file setting using **LIN --> Logging --> Configure** menu. This will show log file configuration dialog as shown below.



Log Files

User can add as many as log files in to the list of Log Files. This list will show the log files that are already configured. To add a new Log file select Add button. This will add a log file with default file name. User can change the file name using "..." button in the Log File Details section. The check box associated with the log file will make the log file eligible for logging. If the check box is not checked logging will not happen to that particular file.

Log File Details

Log file details will give configuration of the selected log file. This will give info of log file path, time mode, numeric mode, file mode, log triggers.

Log File Path

The file path text box will give the selected log file path. To change the path select "..." button. This will show file selection dialog. On selection of a log file, the file path text box will be updated with selected file path.

Log File Size

Log file size is fixed to a limit of 50 MB. This limit is set as most of the editors will take lot of time to open if the file size is large.

Time Mode

Logging of messages can be done in three different time modes. System time, Absolute time and Relative time mode. In system time mode time stamping of message is done using real time clock of the system. In absolute time mode the time stamping is done with respect the to the absolute timer that will be stated during connect. In relative time mode the time stamping of a message is with respect to previously received message.

Reset Timestamp for every enable logging is provided. If this option is selected then the absolute time will be reset whenever the logging is enabled.

Numeric Mode

This tells the numeric format of log file entries. It has two options Hex and Decimal. Message ID and data bytes of a LIN message will use this as a base while format for logging.

File Mode

In Append file mode, log sessions will be appended at the end of the file. Each logging session will have its own session header and footer. In Overwrite file mode the file will be overwritten for the first session. For consecutive sessions the file name will be suffixed with an incrementing number and each session will be logged in new files. The log file name will be incremented every-time when you stop the logging process.

If already log files are created in the previous session and if a new session is started, then the log files created already will be overwritten in both overwrite and append mode. In this case, the successive files already created in the previous session will contain old session data.

Logging Indication

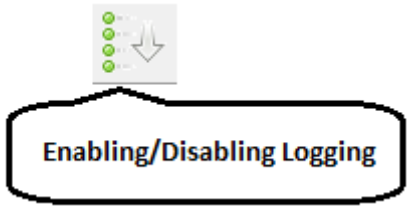
Recording or logging is indicated in the status bar for LIN. When the logging is enabled and data is logged in to the file, an icon will be shown in the status bar with glowing on and glowing off continuously till the logging is stopped. When the logging is stopped then icon will be disabled.

> **Example**
>
> If the log file name is abc.log for the first time, then for the next time the log file name will be abc0.log.
>
> Similarly, if the log file name is abcn.log for the first time, where n – is any number, then for the next time the log file name will be abcm.log, where m = n + 1.

Message Log

LIN messages can be logged to a file for analysis. Log file name shall be selected as described in section Logging.

To start message logging select Log Start or press the Tool Bar Button shown in the figure below. The tool bar is toggle button. Clicking on the button or selecting the menu again will stop logging. Once the logging has started, the messages received and transmitted will be logged in to the file with time of message reception.



Note:

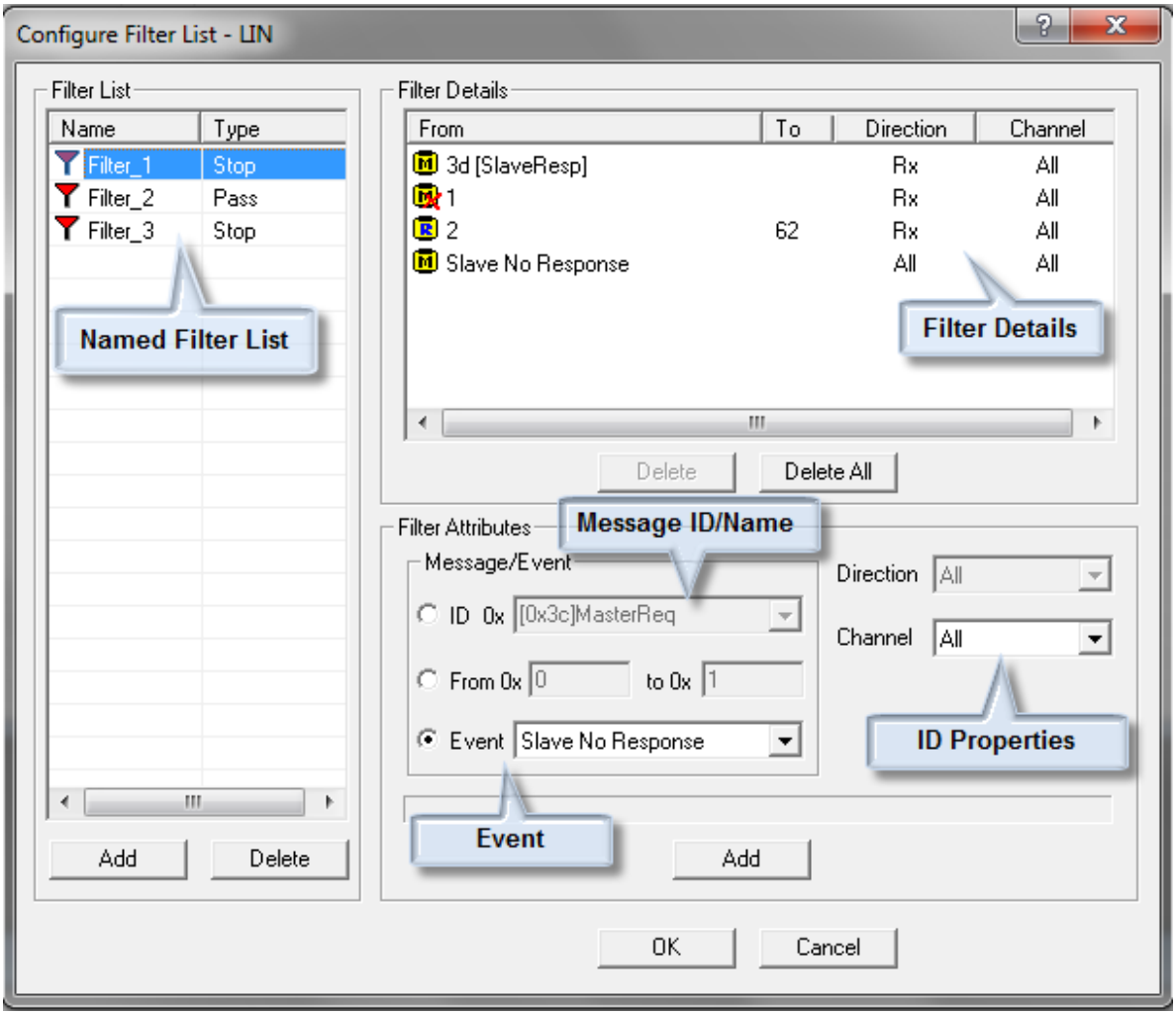
- Logging will fail if the log file is not present in the specified location.
- Logging status is stored in configuration file and logging will be started automatically during application startup if it is enabled and saved in the configuration file.

App Filter

User can configure filter list by choosing messages/events to be filtered.To configure the filter list, follow the steps given below

- Select **LIN --> Filter Configuration**.

- The dialog box specified below will be displayed.



Filter List

It is a list of filters that are identified by the name. The name of the filter should be unique and can have any kind of special characters also. The second parameter tells about the type of the filter, pass or stop. Pass filter allows only the configure message or range of message to pass. On the other size stop filter blocks the configured messages. These filters shall be used in display, logging and replay filters.

Filter Details

This section shows list of message names, ID and range along with ID type, message frame type, direction and channel number. Type is denoted by different icons. Selecting an entry from the list updates the details of the filter in Filter Attributes section.

Filter Attributes

Filter attributes gives more details of selected filter entry. Message Name or ID in case of single id filtering and message ID range in case of range filter will be update. Direction field will show whether the message is transmitted or received. If it is all then direction will be ignored. Channel filed associates the message with particular channel. Channel all makes the message independent of channels.

Database message names shall be selected from the Message ID combo box. Message ID shall be directly typed in this combo box. If the filter is for a range of messages then the Range radio button shall be selected. This will enable range edit boxes. Filter attributes shall be selected based on the filter requirements.

Event radio button shall be selected for Event filter. This will enable Event combo box, from which event type can be selected. Channel combo box will enabled.

The Add button in the Filter Attributes section will add configured filter in to the selected named filter list. This button will be disabled in case of invalid parameter entered by the user and appropriate error message will be displayed in the status bar.

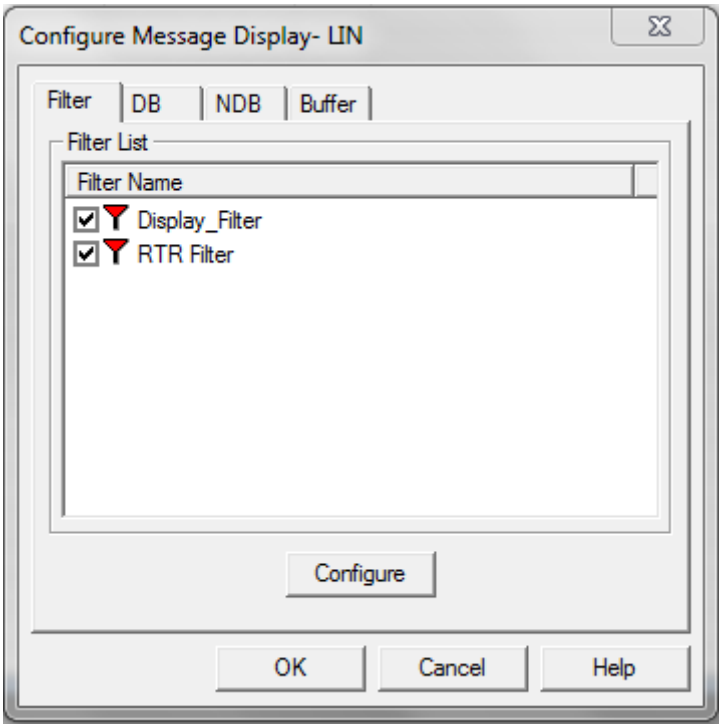
Once the filter is added in to the Filter List then the name of the filter will appear in the Filter Configuration List to select. Any modification on these filter will immediately reflect in the all modules that are using these filters.

Filter list will be saved in configuration file and will be updated while loading a configuration file. While loading a configuration file created with BUSMASTER 3.06.02.X.XXX version one filter entry will be created with the previous filter information.

Message Display

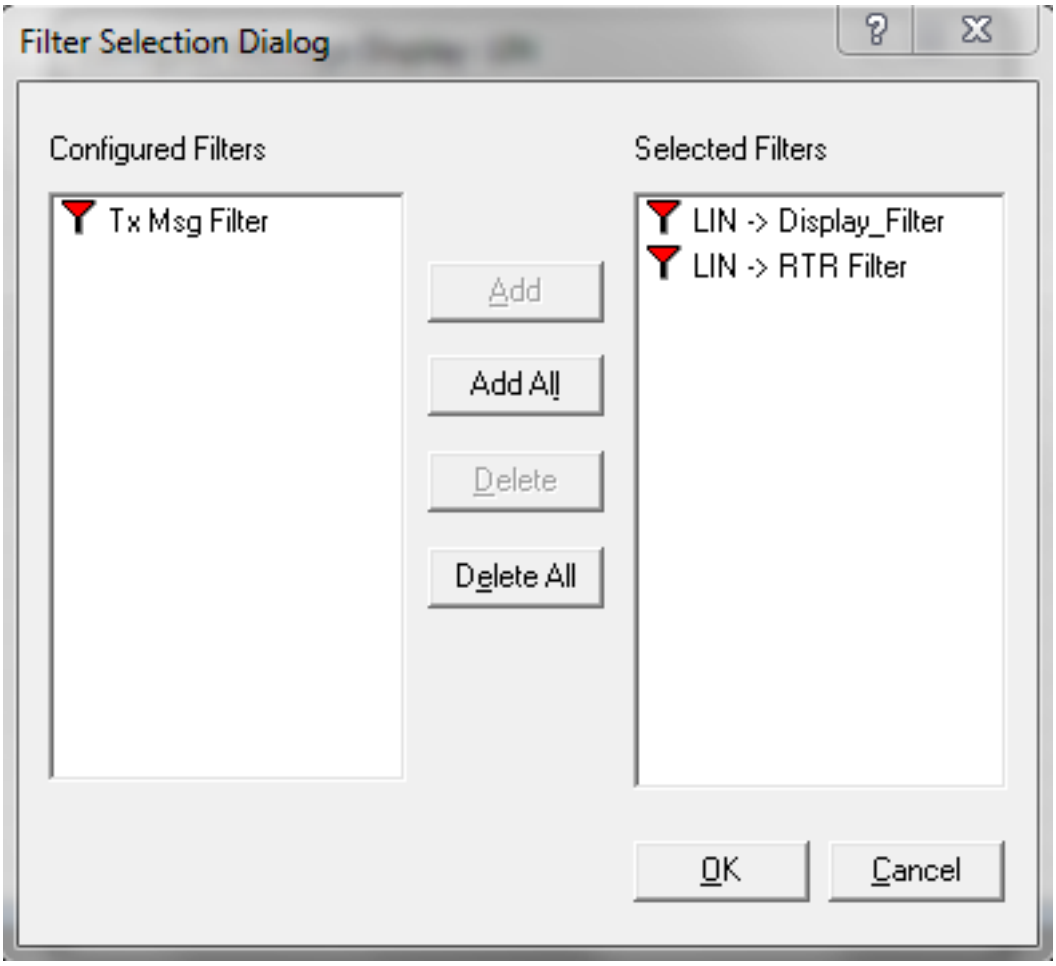
Message Filter

Filters for message display can be configured by selecting **LIN --> Message Window --> Configure** and by selecting Filter tab. This will show list of filters configured for Message Display.



Display Filter

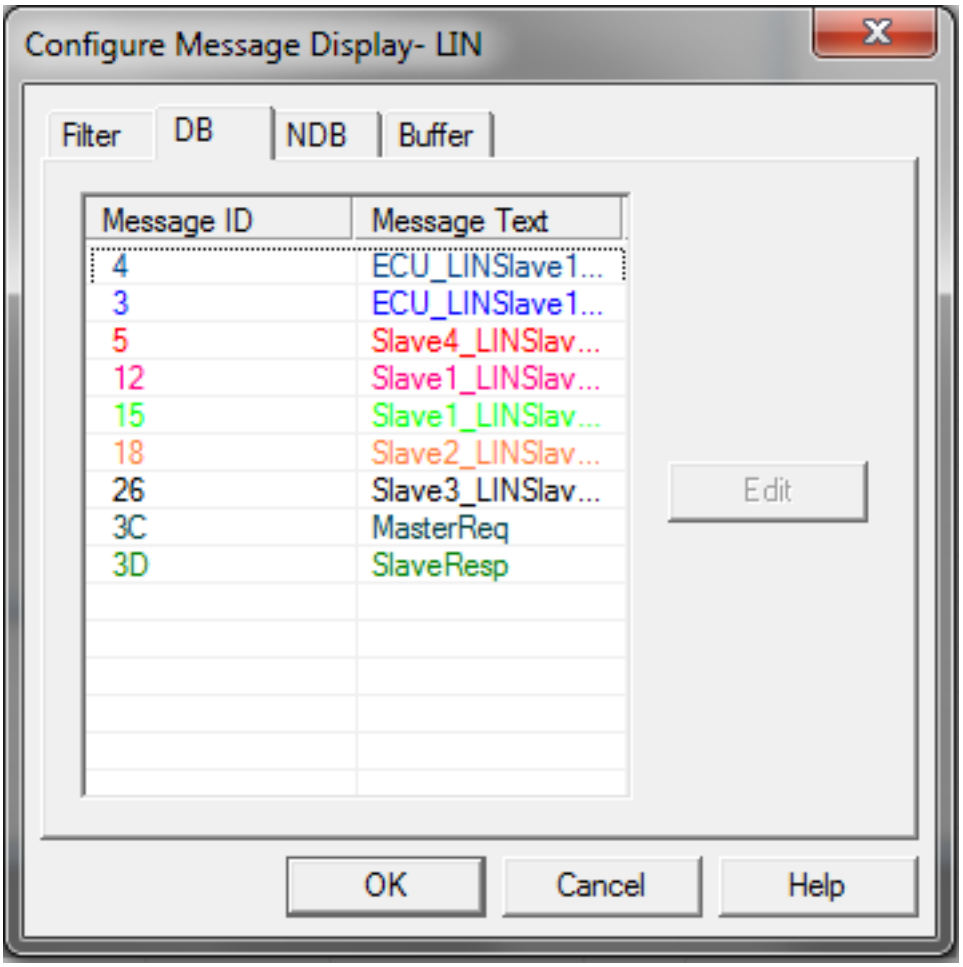
To configure display filter list select Configure button which will list available filters and selected filters.

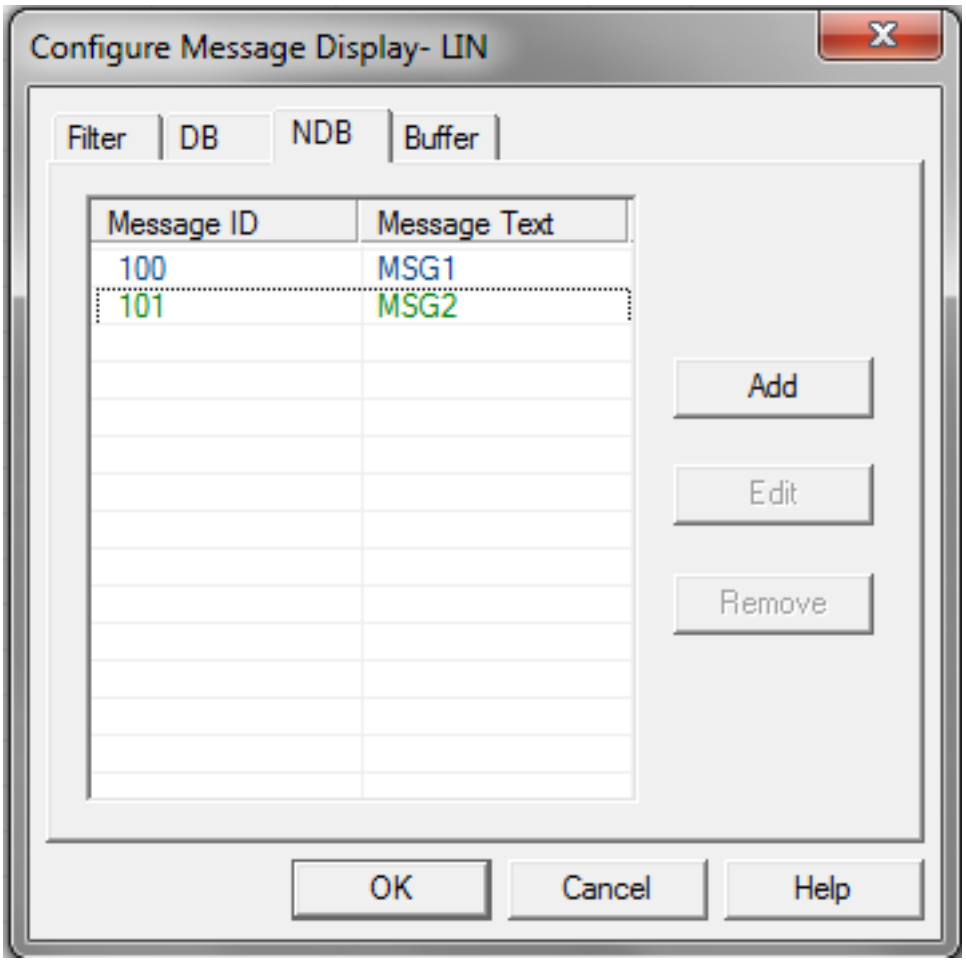


Message Coloring

User can configure the color with which the message will be displayed and associate a textual description to message.

By default all messages are displayed in black color and the message ID itself as the associated text. For the database message user can only edit the color.

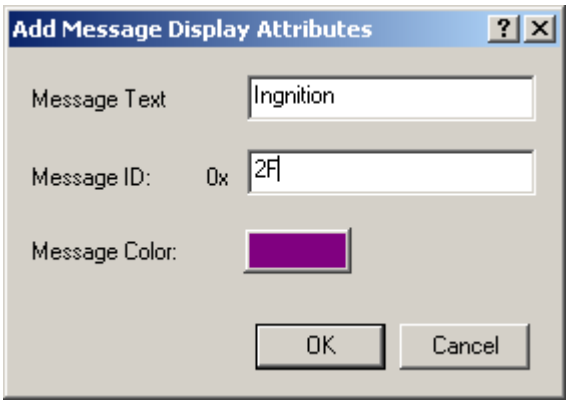

Configure Message Display- LIN
Filter
DB
NDB
Buffer
Message ID
Message Text
4
ECU_LINSlave1...
3
ECU_LINSlave1...
5
Slave4_LINSlav...
12
Slave1_LINSlav...
15
Slave1_LINSlav...
18
Slave2_LINSlav...
26
Slave3_LINSlav...
3C
MasterReq
3D
SlaveResp
Edit
OK
Cancel
Help



Adding message attribute

To configure a message display option, please follow the steps given below

1. Select **LIN --> Message Window --> Configure**
2. Dialog box Configure Message Display as in above figure will be displayed
3. Click on Add button
4. One more dialog box Add Message Display Attributes as shown below will pop up.



5. Enter the message ID and Message text
6. Click on the colored button to select a color, This click pops up a color palette as shown above.
7. Select a suitable color
8. Select OK button to confirm

Subsequent reception / transmission of the message that has been configured will be displayed with associated text & color.

Editing a message attribute

To edit the message attributes please follow the steps given below

1. Select **LIN --> Message Window --> Configure**.
2. Dialog box Configure Message Display will be displayed.
3. Select the message entry to be edited from the message list.
4. Either click on Edit button or double click on the selected entry.
5. One more dialog box Edit Message Attributes will pop up.
6. Change the required Message attributes.
7. Select OK buttons to confirm.

Subsequent reception/transmission of the message that has been configured will be displayed with associated text & color.

Deleting message display attribute

To delete an entry from the Message List follow the steps given below

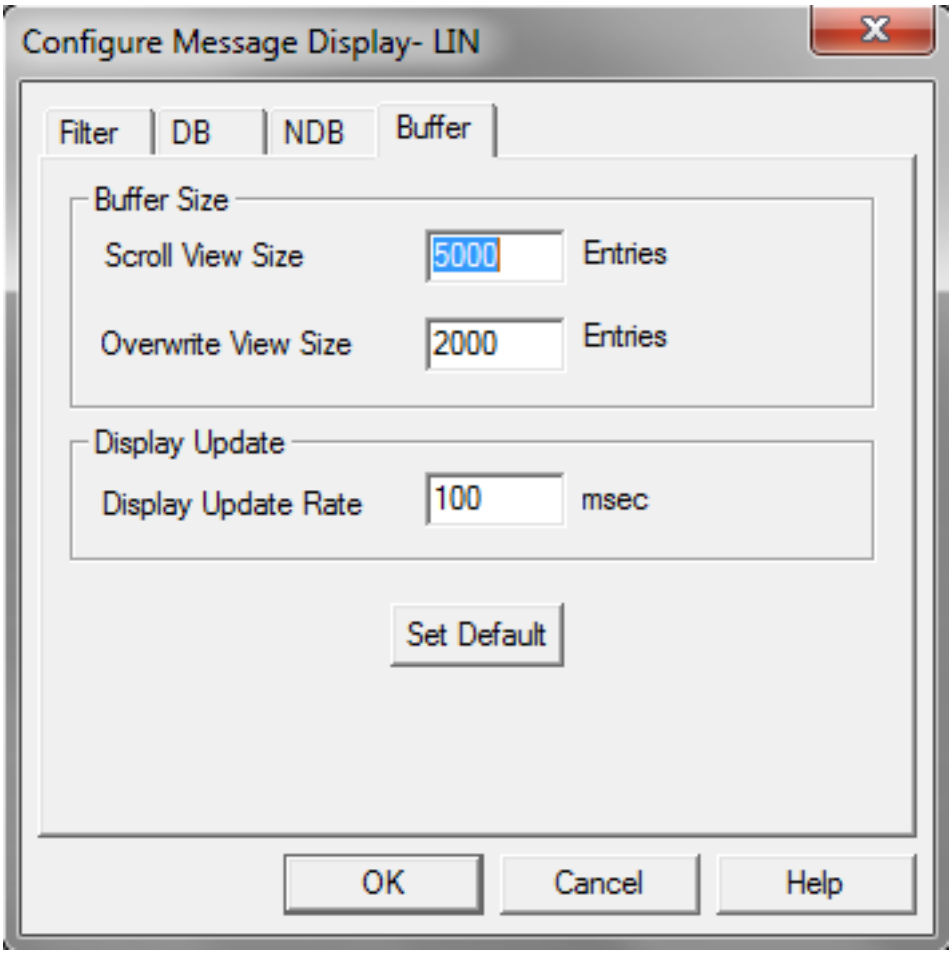
1. Select **LIN --> Message Window --> Configure**.
2. A dialog box will pop up. Select the message entry to be deleted from the message entry list.
3. Click on Remove button. A delete confirmation message box will be displayed.
4. Select Yes to confirm deletion.
5. Select OK button to confirm the modification of entries.

On subsequent reception/transmission, the message will be displayed in black color.

Display Buffer size & Update Rate configuration

To configure Append and overwrite buffer size, follow the steps given below

1. Select **LIN --> Message Window --> Configure**.
2. A dialog box will pop up. Select the Buffer page.



3. The buffer size can be from 200 to 32500 display entries. The display update rate can be from 50 to 20000 milliseconds.
4. Set entries for Append buffer and overwrite buffer. Set display update rate.
5. Select OK button to confirm the modification of entries.
6. Select Set Default button to set the default values.

Show Last Option

This option can be used to set the focus of the list item to the latest item in Scroll mode. In append mode latest message entries will be added at the end. To make the latest entries visible always select **LIN --> Message Window --> Show Last**.

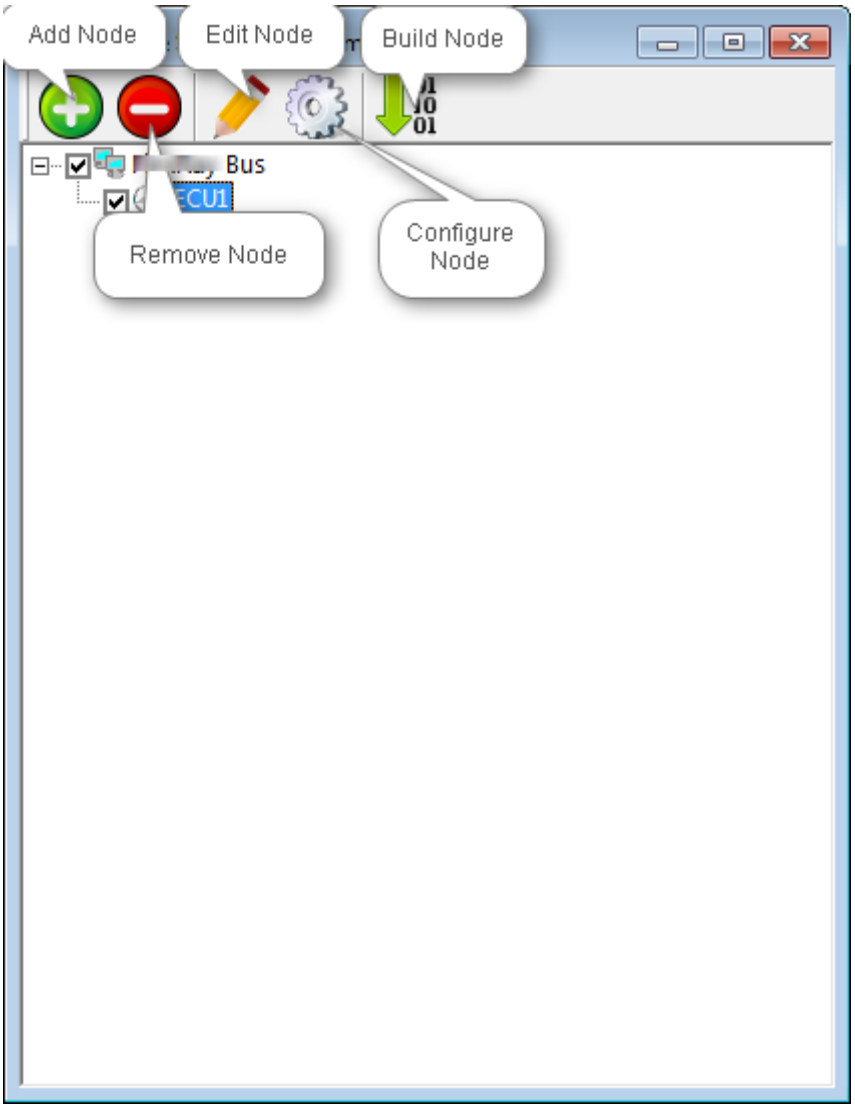
Note:

- In overwrite mode this option will be disabled to avoid rolling of selection.
- Selection will be update only during display update.

LIN Node Simulation

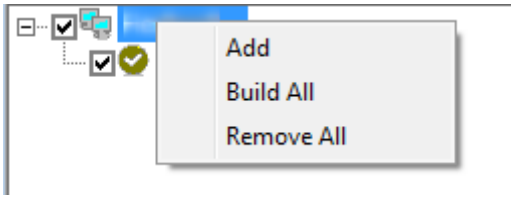
Node Simulation Configuration

Simulated systems can be configured under the <Protocol>-bus by following the steps given below. Select **<Protocol> --> Node Simulation --> Configure** menu option. This will display the window as shown is figure below.



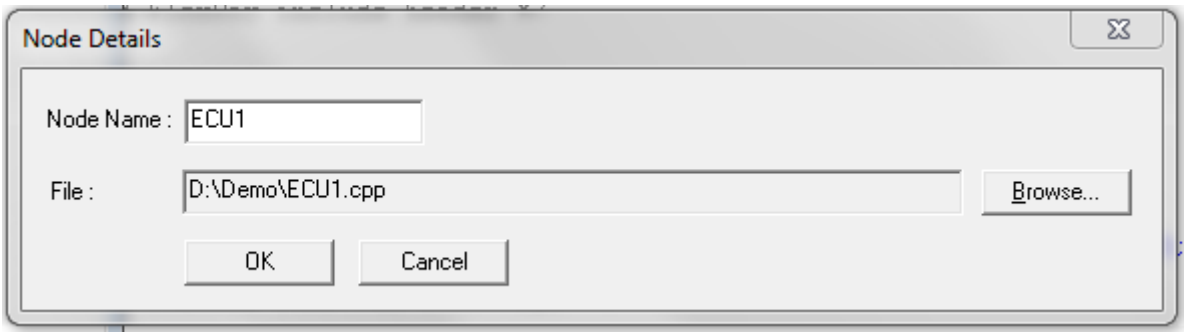
Add Node

This is used to added .cpp/.dll files to Node Simulation. Add Node can be done by following ways:



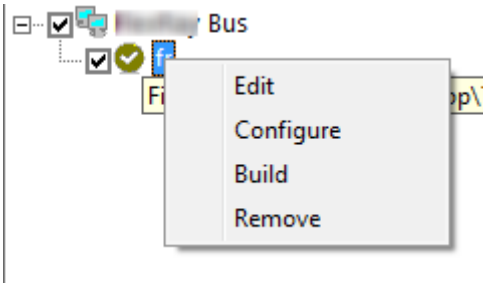
1. Right click the Root Node(<Protocol> Bus) and select "Add".
2. Click Add Node in the toolbar.
3. Pressing "Insert" key in the keyboard.

Then "Node Details" dialog box appears as shown below. Add unique Node name and add existing .cpp/.dll or provide new File name to create new .cpp file.



Edit Node

This is used to edit the .cpp file attached to a Node. Editing can be done by following ways:



1. Select the Node then Right click and select "Edit".
2. Select the Node and click "Edit Node" in the toolbar.
3. Select the Node and press "Enter" key in the keyboard.

Then "Function Editor" window appears in which the required editing can be done.

Remove Node

This is used remove selected node all the nodes in the Simulated system. Removing a Node can be done by following ways:

1. Select the Node then Right click and select "Remove". To Remove All Nodes select Root Node(<Protocol> Bus) and select "Remove All".
2. Select the Node and click "Remove Node" in the toolbar. To Remove All Nodes select Root Node(<Protocol> Bus) and select "Remove Node" in the toolbar.
3. Select the Node and press "Delete" key in the keyboard. To Remove All Nodes select Root Node(<Protocol> Bus) and press "Delete" key.

Configure Node

This is used change the name of the Node or change/add .cpp/.dll associated with a Node. Configuring a Node can be done by following ways:

1. Select the Node then Right click and select "Configure".
2. Select the Node and click "Configure Node" in the toolbar.
3. If no .cpp/.dll files are associated with the node previously, then by pressing "Enter" key in the keyboard.

Build Node

This is used build the .cpp files associated with selected Node or all the nodes in the Simulated System. Building a Node can be done by following ways:

1. Select the Node then Right click and select "Build". To Build All Nodes select Root Node(<Protocol> Bus) and select "Build All".
2. Select the Node and click "Build Node" in the toolbar. To Build All Nodes select Root Node(<Protocol> Bus) and select "Build All" in the toolbar.

Enable/Disable Node

This used to active/deactivate selected Node or all the Nodes in the Simulated System. Enabling/Disabling can be done by following ways:

1. Check/Uncheck the checkbox associated with the Node will Enable/Disable the Node respectively. To Enable/ Disable all the Nodes Check/Uncheck the Root Node(<Protocol> Bus) respectively.
2. "Spacebar" key can be used as keyboard shortcut to Check/Uncheck the Node(s).

Note:

1. Node(s) can't be Added/Removed/Configured/Enabled/Disabled while the network is connected.
2. A Node can be edited while the network is connected. But the file must be built again to see the changes.

Function Editor

BUSMASTER can work as a programmable node over a LIN bus. User can program different event handlers using function editor. The programming language is C/C++.

Six types of event handlers are supported.

- Bus Events
- Message Handlers
- Timer Handlers
- Key Handlers
- Error Handlers
- DLL Handlers

These function handlers when built and loaded are executed on

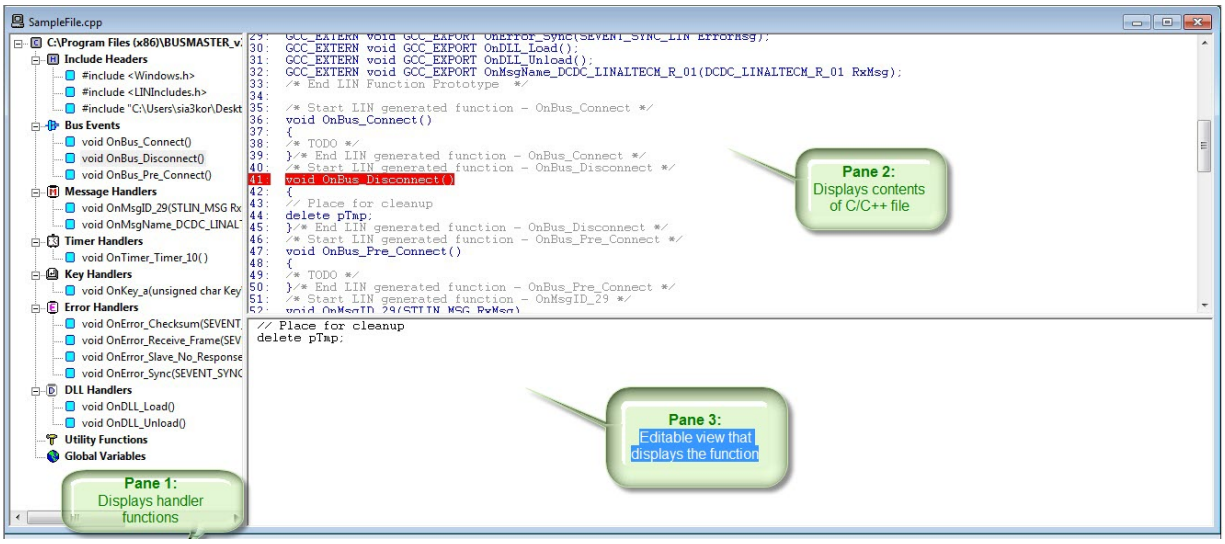
- Bus connect and disconnect
- Receipt of a Message.
- Elapse of a time interval.
- Press of a Key
- Detection of error or change in error state
- Loading / unloading of DLL.

User can also include Header File names, add Global Variables and Utility Functions while programming the event handlers. All these functions can be edited and saved in a file with extension ".cpp". The source file can be built to a DLL. This DLL can be loaded dynamically.

There are three panes in function editor as shown below

- Left Pane : Will be called Pane 1.
- Right Top Pane : Will be called Pane 2.
- Right Bottom Pane : Will be called Pane 3.

Pane 1 displays the list of functions, included header files and global variables defined. Pane 2 displays the contents of the source file. Through Pane 3 User can edit the body of function selected.



General access to the function editor

Go to **LIN --> Node Simulation --> Configure** to open the window **Configure Simulated Systems**. Right click on **LIN Bus** in the left pane and select **New Simulated System** or **Add Simulated System** . Select then the "sim" file.

Right click on the new simulated system and select **Add Node** . The name will also be used as basename for the generated DLL. The **Node Details** will become visible in the right pane.

Create a new function

Follow the description in the previous chapter "General access to the function editor".

Select **Add New File...** in the right pane under **File Details** to add new functions to the node. The function editor will open automatically.

Edit an existing function

Follow the description in the previous chapter "General access to the function editor".

Select **Edit File...** in the right pane under **File Details** to edit an existing function of the node.

Include Header file

User can include a header filename while programming event handlers. To do so please follow the steps given below:

1. Select **Include Headers** category in the Pane 1 and right click.
2. A pop-up menu comes up. Select **Add**. A dialog box appears.
3. Click on **Browse** button to select the required header file name and click on **OK** button.
4. The selected header filename will be added to the source file in the Pane 2 and also under **Include Headers** category in Pane 1.

Edit Include Header File Name

User can edit the name of the header file, to do so please follow the steps given below

1. Select the **Include Header** filename under **Include Header** category to be edited in the Pane 1 and Right click.
2. A pop-up menu will be displayed.
3. Select **Edit**.
4. A dialog box will be displayed.
5. Click on **Browse** button to select the required header file and click on **OK** button.

The selected header file will be replaced with the previous header file in the source file in the Pane 2 and also under **Include Headers** category in Pane 1.

Delete Handlers

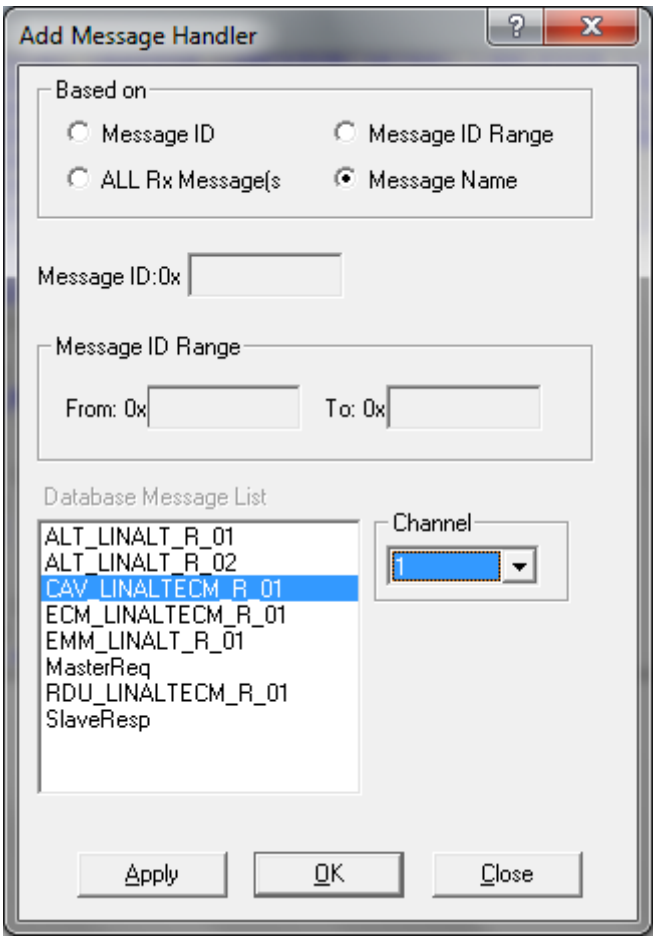
User can delete Header files, Message Handlers. Timer Handlers, Key Handlers, Error handlers, DLL handlers and Utility Functions in source file opened for editing, to do so follow the steps given below:

1. Select the item to be deleted in the Pane 1 and right click.
2. A pop-up menu will be displayed.
3. Select **Delete**.
4. A confirmation message is displayed.
5. Select **Yes**.

The selected item's definition will be deleted from the source file in the Pane 2 and also in Pane 1.

Add Message Handler

1. Select **Message Handlers** category in the Pane 1 and right click.
2. A pop-up menu will be displayed.
3. On selecting **Add** menu. A dialog as shown below pops up.



4. From this dialog message handlers of different type can be selected. The different types of message handlers supported are

   - Message handler based on the message name.
   - Message handler based on message ID.
   - Message handler based on range of message ID.
   - Message handler for all received messages.

The type of message handler can be selected using the radio buttons. To add handler based on the message name the corresponding message should be available in the imported database. Multiple messages can be added from this dialog box by clicking on **Apply** button after selecting a message handler.

Function definition will be added to the source file in the Pane 2 and the prototype under Message Handlers category in Pane 1.

Add Timer Handler

1. Select **Timer Handlers** category in the Pane 1 and right click.
2. A pop-up menu will be displayed.
3. Select **Add**. A dialog box appears.
4. Enter Timer Handler Name like e.g., "Time_One" and the Timer Value in milliseconds.
5. Select **OK** button.
6. Function definition will be added to the source file automatically in the Pane 2 and the prototype under Timer Handlers category in Pane 1.

Note:

- Adding a Sleep function inside a Timer handler might have an adverse effect on the application.
- Maximum of 16 timers can run simultaneously in cyclic mode. Anything above 16 will fail to start.

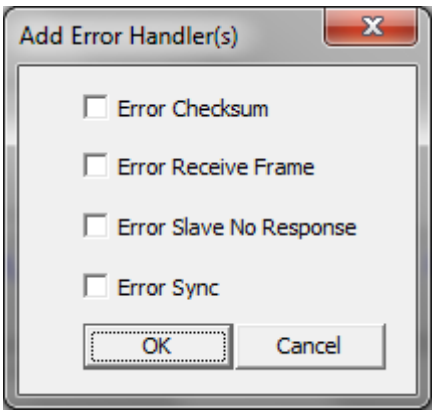
Add Key Handler

1. Select **Key Handlers** category in the Pane 1 and right click.
2. A pop-up menu will be displayed.
3. Select **Add**. A dialog box appears asking the user to press a key.
4. Press a key for which User want to write the handler. The same will be displayed in the dialog box.
5. Select **OK** button or **Apply** button if more key handlers are to be added from the same dialog.

Function definition will be added to the source file automatically in the Pane 2 and the prototype under Key Handlers category in Pane 1.

Add Error Handler

1. Select **Error Handlers** category in the Pane 1 and right click.
2. A pop-up menu will be displayed.
3. Select **Add**. A dialog as shown below pops up from this dialog select the type of error handlers to he handled by your program and click on **OK** button.



Function definition will be added to the source file automatically in the Pane 2 and the prototype under Error Handlers category in Pane 1.

Add DLL Handler

DLL handlers are invoked at the time of loading the DLL or while unloading the DLL. The procedure for adding DLL handlers is similar to that of adding error handlers.

Add Utility Function

1. Select **Utility Functions** category in the Pane 1 and right click.
2. A pop-up menu comes up.
3. Select **Add**. A dialog box appears.
4. Return Type of the utility function can be selected from the combo box or directly typed. The combo box will have primitive data types and database message structure names.
5. Enter the Function Prototype in the Edit control like e.g., "Func_One(int a, int b)".
6. Select **OK** button.

Function definition will be added to the source file automatically in the Pane 2 and the prototype under Utility Functions category in Pane 1.

Global Variables

To add/delete/modify global variables follow the steps given below.

1. Select **Global Variables** category in the Pane 1 and double click.
2. The Pane 3 will become editable and will show global variable block.
3. Change this block to Add/Delete/Modify the global variables.

Variable declaration will be added to the source file automatically in the Pane 2.

Note:

- Use global variable block to use macros, structure or union definitions. The scope of variables and definitions given in this block is throughout the program.

Edit Function Body

User can edit any function body by double clicking the prototype of the function displayed in Pane 1. On double click of the function prototype, the function body will be displayed in the Pane 3 and will be ready for editing.

Variable of Message Type

BUSMASTER defines structures for messages define in the database. User can use these structures while programming. Please follow the steps below to add variable of the message type

1. Edit the function for which database message name is to be added. (Refer: section Edit Function Body)
2. Right click in the Pane 3.
3. A pop-up menu is displayed.
4. Select **Insert Message**. A dialog box is displayed with all the database messages under Message list.
5. Choose a message from the list.
6. Select the check box option in the dialog box.
7. Click on **Select** button.

The selected message variable will be displayed in the Pane 3 and the same is updated in the Pane 2.

Insert Message name

User can add a tag of message structure and this could be used for defining variables. Please follow the steps below to insert a message structure tag into the function.

1. Edit the function for which database message name is to be added. (Refer: section Edit Function Body)
2. Right click in the Pane 3.
3. A pop-up menu is displayed.
4. Select **Insert Message**. A dialog box is displayed with all the database messages under Message list.
5. Choose a message from the list and click on **Select** button.
6. The selected message will be displayed in the Pane 3 and the same is updated in the Pane 2.

Insert Signal name

User can use signal names while programming. The signal names have to be used in conjunction with the corresponding message variable. It is member of message structure. Please follow the steps below to insert a signal name into the function.

1. Edit the function in which signal name is to be added. (Refer: section Edit Function Bodyedit_function_body)
2. Right click in the Pane 3. A pop-up menu is displayed.
3. Select **Insert Signal**. A dialog box is displayed with all the database messages under Message list.
4. Choose a message from the list. A list of signals will be displayed under Signals list.
5. Select a signal and click on **Select** button.
6. The selected signal will be displayed in the Pane 3 and the same is updated in the Pane 2.

Insert a Function

BUSMASTER provides API functions, which can used while programming. These functions can be used to interact with BUSMASTER application. Please follow the steps below to insert a function

1. Edit the function for which prototype is to be added. (Refer: Editing Function Body)
2. Right click in the Pane 3. A pop-up menu is displayed.
3. Select **Insert** Function. A dialog box is displayed with a set of function prototypes. (API Listing)
4. Choose required function prototype from the list and click on **OK** button.
5. The selected function prototype will be displayed in the Pane 3 and the same is updated in the Pane 2.

Responding to Master Request

To respond to the master request, slave response of the particular identifier needs to be pre-configured on Pre Connect Event.

Example:

For example to respond to the master request with an identifier 0x4, Pre-Connect event shall be configured as shown below:

```
void OnBus_Pre_Connect()
{
  STLIN_MSG sMsg;

  sMsg.m_ucMsgTyp = 1; // Slave Response
  sMsg.m_ucChksumTyp = 0; // Classic
  sMsg.m_ucDataLen = 8;
  sMsg.m_ucMsgID = 0x4;  // Message Identifier
  sMsg.m_sWhichBit.m_aulData[0] = 10;  // Lower 4 Bytes
  sMsg.m_sWhichBit.m_aulData[1] = 20;  // Upper 4 Bytes
  sMsg.m_ucChannel = 1;

  // Send the message
  SendMsg(sMsg);
}
```

Required Include header file is LINIncludes.h

LIN API Reference

STLIN_MSG Structure

STLIN_MSG Structure Definition

```
struct sTLIN_MSG
{
    unsigned char m_ucMsgTyp;       // Header - 0, Slave Response - 1
    unsigned char m_ucChksumTyp;    // Checksum Type (0 - Classical / 1 -
 Enhanced)
    unsigned char m_ucDataLen;      // Data length (0..8)
    unsigned char m_ucMsgID;        // LIN Identifier
```

```
    union
    {
        UCHAR m_aucData[8];                 // Byte Data
        USHORT m_auwData[4];                // Word Data
        UINT m_aulData[2];                  // Long Data
    } m_sWhichBit;                          // Data access member
    unsigned long m_ulTimeStamp;
    unsigned char m_ucChannel;              // Channel Number
    unsigned char m_ucCRC;                  // Checksum - Read Only

} STLIN_MSG;
```

Required Include header file is LINIncludes.h

Input Parameters:

m_ucMsgTyp

0 - Sets message type as Header

1 - Sets message type as Response

m_ucChksumTyp

0 - Sets checksum type as Classic

1 - Sets checksum type as Enhanced

m_ucDataLen

dlc of the LIN message. Valid range of LIN data length is 0..8.

m_ucMsgID

LIN message identifier

m_aucData, **m_auwData, m_aulData**

Contains data bytes

m_sWhichBit

To access/update Data bytes

m_ulTimeStamp

Actual time stamp of the received message

m_ucChannel

Channel number

m_ucCRC

Checksum value of the received message

STLIN_Msg Example:

```
STLIN_MSG sMsg;

sMsg.m_ucMsgTyp = 1; // Slave Response
sMsg.m_ucChksumTyp = 0; // Classic
sMsg.m_ucDataLen = 8;
sMsg.m_ucMsgID = 0x4;
sMsg.m_sWhichBit.m_aulData[0] = 10;  // Lower 4 Bytes
sMsg.m_sWhichBit.m_aulData[1] = 20;  // Upper 4 Bytes
sMsg.m_ucChannel = 1;

// Send the message
SendMsg(sMsg);
```

Event Structure:

SEVENT_CHECKSUM_LIN Structure Definition

```
struct SEVENT_CHECKSUM_LIN
```

```
{
    unsigned char m_ucId;
    unsigned char m_ucCrc;
    unsigned char m_ucChannel;
    unsigned int  m_ulTime;
};
```

SEVENT_RECEIVE_LIN Structure Definition

```
struct SEVENT_RECEIVE_LIN
{
    unsigned int  m_ulTime;
};
```

SEVENT_SLAVE_NORESP_LIN Structure Definition

```
struct SEVENT_SLAVE_NORESP_LIN
{
    unsigned char m_ucId;
    unsigned char m_ucChannel;
    unsigned int  m_ulTime;

};
```

SEVENT_SYNC_LIN Structure Definition

```
typedef struct SEVENT_SYNC_LIN
{
    unsigned char m_ucChannel;
    unsigned int  m_ulTime;

};
```

Required Include header file is LINIncludes.h

Accessing database message signal values

Database message structures can be meaningfully interpreted. Database message structures will have signal members as defined in the database. Signal raw value can be directly assigned by using member of database message structure with the signal name.

LIN_Request is a database message that has signals Sig1, Sig2 and Sig3. Each signal is 2 bytes of length. To assign raw value of a signal use message name structure and use signal name as member.

```
// Message Declaration
LIN_Request sMsgStruct = { 1, 0, 8, 0x4, { 0, 0, 0, 0, 0, 0, 0, 0 } };

// Use signal member

// Sig1
sMsgStruct.m_sWhichBit.Sig_1 = 10;

// Sig2
sMsgStruct.m_sWhichBit.Sig_2 = 20;

// Sig3
sMsgStruct.m_sWhichBit.Sig_3 = 30;

// Send the message now
SendMsg(*((STLIN_MSG *)&sMsg));
```

Right click on edit area of function editor. Select "Insert Message" or "Insert Signal" option to insert message structure or signal structure. Select the option "Yes, I want to declare selected message structure variable" option in the "Message and Signal List" to initialise message with its struct definition.

Required Include header file Unions.h

Note:

- Unions.h file will be automatically generated by BUSMASTER during database import.
- This file will be in the database file directory

LIN API Listing

BUSMASTER API Listing

SendMsg : To send a LIN frame

Synopsis

```
UINT SendMsg ( STLIN_MSG )
```

Description

This function will put the message on the LIN bus. The message structure STLIN_MSG will be filled with ID, length, message type, checksum type and data.

Inputs

STLIN_MSG - LIN Message Structure

Returns

Zero on successful transmisstion. Non-zero value on failure.

Trace : To send string to Trace window

Synopsis

```
UINT Trace ( char* format, ... )
```

Description

This function will format the passed parameters based on format specified and will show the formatted text in TRACE window. The return value of this function will be 0 or 1.

Inputs

msg - Pointer to character array

Returns

A value zero indicate failure condition while a value 1 indicate a success condition. This function can return 0 in case user has passed a NULL pointer. If the TRACE window is visible, it will be made visible

Disconnect : To disconnect the controller from the bus

Synopsis

```
UINT Disconnect (DWORD dwClientId )
```

Description

This function will disconnect the tool from correponding protocol bus. The return value of this function will be 0 or 1. This function can return 0 in case tool is already disconnected. dwClientId is reserved for future use.

Inputs

Client ID. Currently unused.

Returns

A value zero indicate failure condition while a value 1 indicate a success condition.

Connect : To connect controller to the bus

Synopsis

```
UINT Connect (DWORD dwClientId )
```

Description

This function will connect the tool to corresponding protocol bus. The return value of this function will be 0 or 1. This function can return 0 in case tool is already connected. dwClientId is reserved for future use.

Inputs

Client ID. Currently unused.

Returns

A value zero indicate failure condition while a value 1 indicate a success condition.

StartTimer : To start a timer in specific mode

Synopsis

```
UINT StartTimer ( char* strTimerName, UINT nTimerMode )
```

Description

This function will start timer having name passed as parameter strTimerName in monoshot or cyclic mode. The function takes first parameter as timer name and second as mode, monoshot or cyclic. If the named timer is already running or timer name is not matched, the function will return FALSE. Otherwise function be return TRUE.

Inputs

strTimerName - Name of the timer. i.e. OnTimer_Tester_Present_100 nTimerMode - Mode of the timer. 1 - Start in Cyclic mode 0 - Start in Monoshot mode

Returns

1 on success. 0 if the timer is already running or timer name not found

StopTimer : To stop a running timer

Synopsis

```
UINT StopTimer ( char* strTimerName)
```

Description

This function will stop timer having name passed as parameter strTimerName. If the named timer is not running or timer name is not matched, the function will return FALSE. Otherwise function be return TRUE.

Inputs

strTimerName - Name of the timer. i.e. OnTimer_Tester_Present_100

Returns

1 on success. 0 if the timer is already running or timer name not found

hGetDllHandle: To get handle of dll attached to a node from the node

Synopsis

```
HANDLE hGetDllHandle ( char* strNodeName)
```

Description

This function returns the handle of the dll attached to a node. The node name will be passed as parameter.

Inputs

Node name

Returns

Dll handle on success else NULL

EnableLogging : To start logging

Synopsis

```
UINT EnableLogging ( )
```

Description

This function will enable logging. The return value of this function will be 0 or 1.

Inputs

-

Returns

A value zero indicate failure condition while a value 1 indicate a success condition. This function can return 0 in case logging is already ON

DisableLogging : To stop logging

Synopsis

```
UINT DisableLogging ( )
```

Description

This function will disable logging. The return value of this function will be 0 or 1.

Inputs

-

Returns

A value zero indicate failure condition while a value 1 indicate a success condition. This function can return 0 in case logging is already OFF

WriteToLogFile : To send string to log file

Synopsis

```
UINT WriteToLogFile ( char* msg )
```

Description

This function will output text passed as parameter "msg" to all log files. The return value of this function will be 0 or 1.

Inputs

msg - Pointer to characterarray

Returns

A value zero indicate failure condition while a value 1 indicate a success condition. This function can return 0 in case logging is OFF or user has passed a NULL pointer.

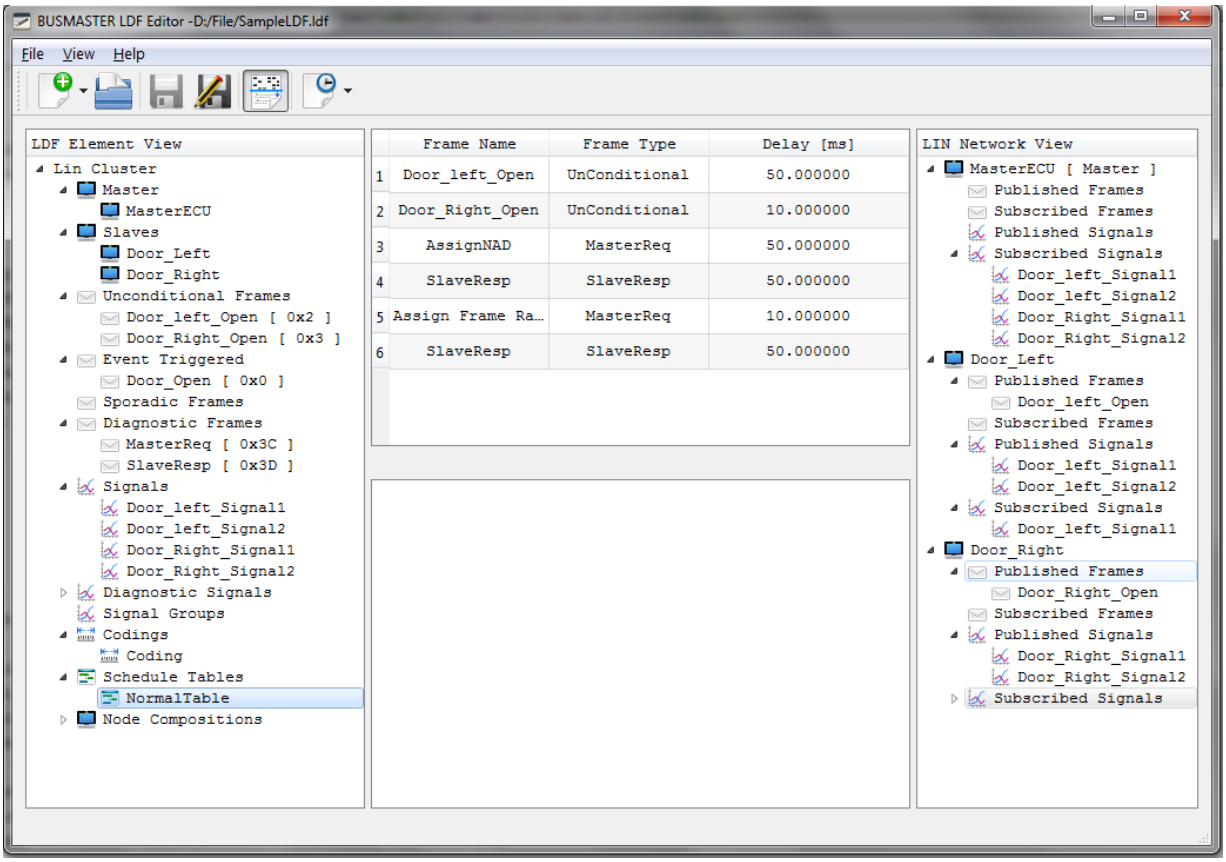
LIN Database Editor

Introduction

LIN Database Editor Overview

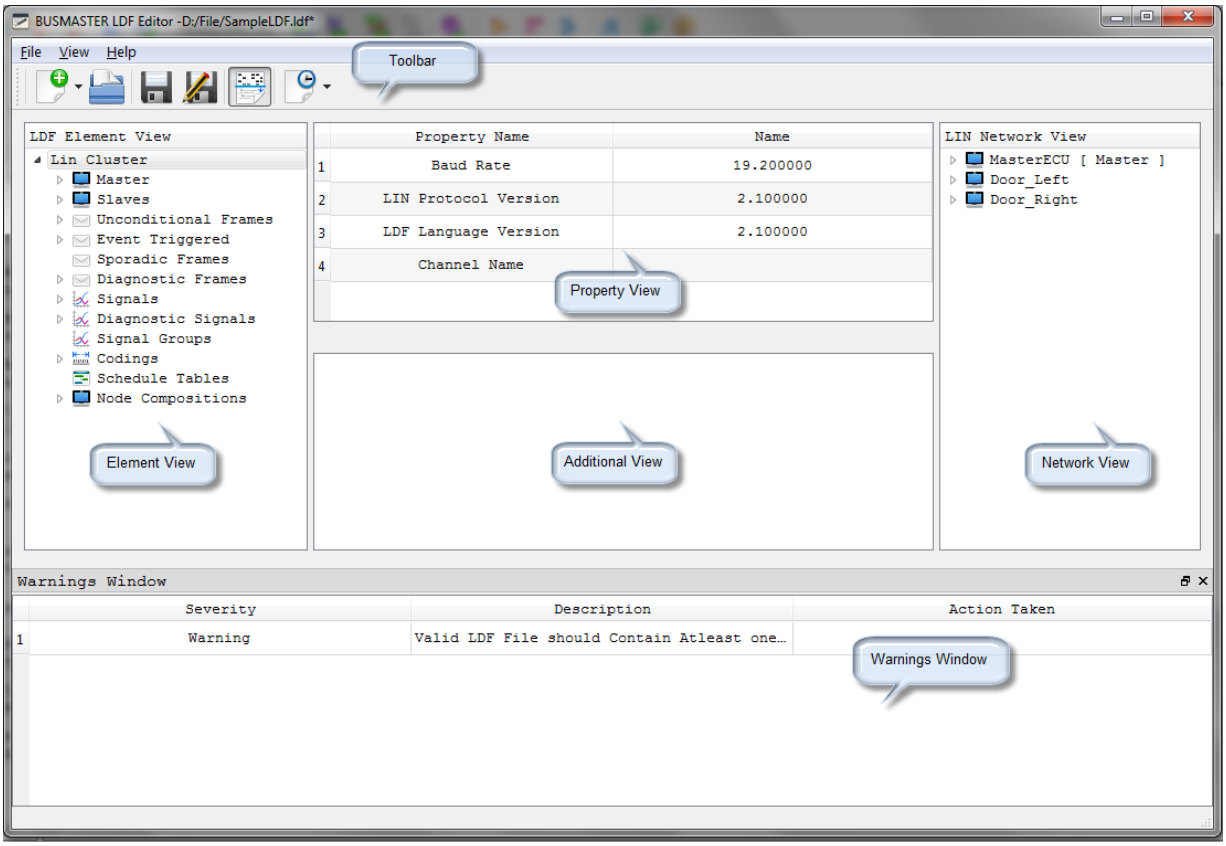
BUSMASTER LIN Database Editor is a user friendly tool to create, edit and view LIN Description Files(LDF). LIN Database Editor supports LDF versions 1.3, 2.0 and 2.1.

Using LIN Database Editor user can create LIN Description files with out knowing the details of LIN Description file format



Overview

LIN Database Editor main window is as shown below:



Menu bar:

- File Menu

  1. File->New->LIN 1.3

     Creates LIN 1.3 LDF file. Default elements will get created.
  2. File->New->LIN 2.0

     Creates LIN 2.0 LDF file. Default elements will get created.
  3. File->New->LIN 2.1

     Creates LIN 2.1 LDF file. Default elements will get created.
  4. File->Open

     To Open an existing LDF file of versions 1.3, 2.0 and 2.1.
  5. File->Save

     To Save the changes to the current loaded LDF file.
  6. File->Save As

     To Save changes to a new LDF file.
  7. File->Recent Files

     Displays 5 recently viewed LDF files.Click on the file to load the LDF file.
- View Menu

  1. View->Hex

     Select/DeSelect Hex to toggle between numeric modes Hex/Dec.
  2. View->Preview LDF File

     Opens the current LDF file in LDF file editor.
  3. View->Warnings Window

     Populates the Warning Window, which displays the list of warnings with description and action taken if any.

Toolbar:

Toolbar can be used for creating, loading, saving LDF files and also to set the numeric mode (hex/dec).

Element View:

Element view displays the LIN Cluster elements by which user can create or edit elements.

To Create a new element, right click on the element in the element view and select the pop up menu 'New'.

To Edit a element, right click on the element in the element view and select the pop up menu 'Edit'

To Delete a element, right click on the element in the element view and select the pop up menu 'Delete'. Confirmation message is displayed before deleting the element.

The following LIN Cluster elements are displayed in Element View.

- Lin Cluster Settings
- Master
- Slaves
- Unconditional Frames
- Event Triggered Frames
- Sporadic Frames (Displayed for LDF version 2.0 and 2.1)
- Diagnostic Frames
- Signals
- Diagnostic Signals
- Signal Groups
- Codings
- Schedule Tables
- Node Compositions (Displayed for LDF version 2.0 and 2.1)

On selecting an element in the element view, Property view and additional view will be updated with selected element properties.

Property View:

Property view displays the properties of the element selected in the element view.Properties are populated based on the type of element selected in the element view.

Additional View:

Additional view displays the additional properties of the element selected in the element view.Properties displayed in the additional view will vary based on the type of element selected in the element view.

Table 3:

Selected Element	Properties displayed
Node (Master/Slave)	1. Node Attributes 2. List of published frames
Frame (Unconditional, Event Triggered, Sporadic and Diagnostic frames)	1. Frame Attributes 2. List of published signals
Signals (Normal and Diagnostic Signals)	1. Signal Attributes 2. List of Codings mapped to the signal
Codings	1. Coding Attributes
Schedule Table	1. Schedule Table Items 2. Schedule Table attributes populated based on the type of the frame selected

Signal Groups	1. Signal Group properties 2. Signals mapped to the Signal group
Node Compositions	1. List of Composite nodes mapped to the Node Configuration

Network View:

Network view displays the Master and Slave nodes. Published, subscribed frames and signals will be displayed under respective node.

On Selecting an element in the network view respective element in the element view is selected and elements properties are displayed in the Property view and Additional view.

Warning Window:

On Save or Load LDF file, warning will be displayed in the Warnings window if exists any with description and action taken is specified if any action is performed to correct the warning.

Getting Started

1. Creating LDF File Using LDF Editor:

Currently LDF Editor supports creation of LDF 1.3, 2.0 and 2.1 versions.

Recommended work flow to create a LDF file:

1. Create LDF File using File->New->LDF <*version*>.LDF Editor will create a Master and a Slave node with default parameters.
2. Create slaves if required. (Refer section : *Slave* on page 172)
3. Create signal and provide its Publisher and subscribers (Refer section:*Signals* on page 183)
4. Create unconditional Frames and map publisher and signals. (Refer section:*Unconditional Frame* on page 175)
5. Create Event triggered and sporadic frames if required (Refer sections:*Event Triggered Frame* on page 178 and *Sporadic Frame* on page 180)
6. Add Diagnostic Messages and signals if required (Refer section:*Diagnostic Support* on page 182)
7. Create schedule table(s) and define slots (Refer section:*Schedule Table* on page 189)
8. Create codings and associate to signals (Refer section:*Signals* on page 183)
9. Create signal groups if required.Signal groups are depreciated from LDF 2.x (Refer section:*Signal Group* on page 185)
10. Create Node compositions if Required (Refer section:*Node Composition* on page 190)

2. Importing\Editing LDF File:

Use File->Open to import the existing LDF file.If any errors found tool will report the same and file not be loaded.If any warnings are found tool will display the same in warnings window with the description, action point if any and imports LDF File

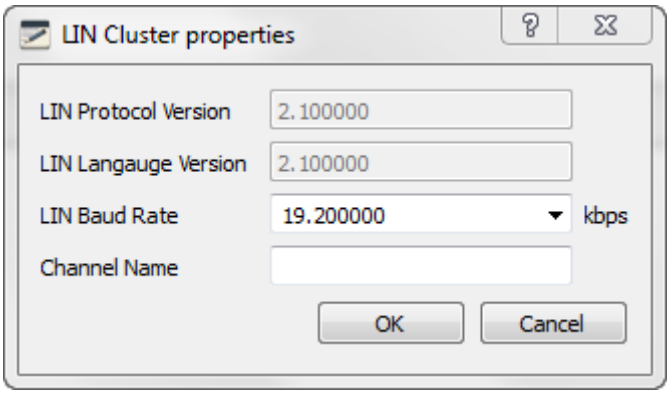
3. Preview LDF File:

To preview the current LDF File use View->Preview File menu.

LDF Elements

Cluster Properties

The LIN Cluster parameters can be edited by Right clicking the LIN Cluster Element in Element View and click on pop up menu '*Edit*'.A dialog Box as Shown in below image will be displayed.



1. Lin protocol and Language versions are read only sections.

2. Baud rate of the Lin cluster can be defined in the LIN Baud rate Section.

3. Channel Name can be provided in **Channel Name** section.This field is available from LDF2.1 version.

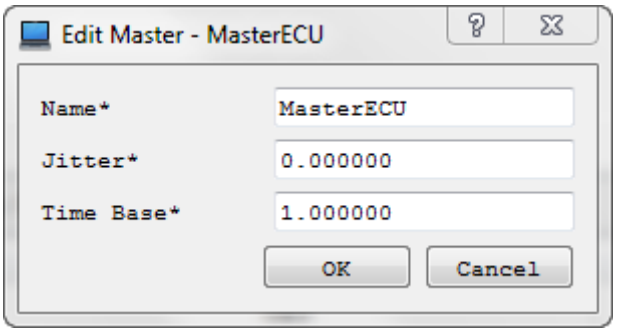
Master

Creating Master ECU:

When a new LDF File is crated with LDF Editor a master node will with default values will be crated automatically

Editing Master ECU Properties:

To edit the properties of master ECU right click on the Master node item in the Element view and click on 'Edit'. A dialog will be displayed as shown below.



To save the changes click on 'OK' button. Errors are displayed if validation fails.

The following validations are performed:

- ECU name will be checked for its uniqueness

To discard the changes click on 'Cancel' button.

Deleting Coding:

Master Node can not be deleted.

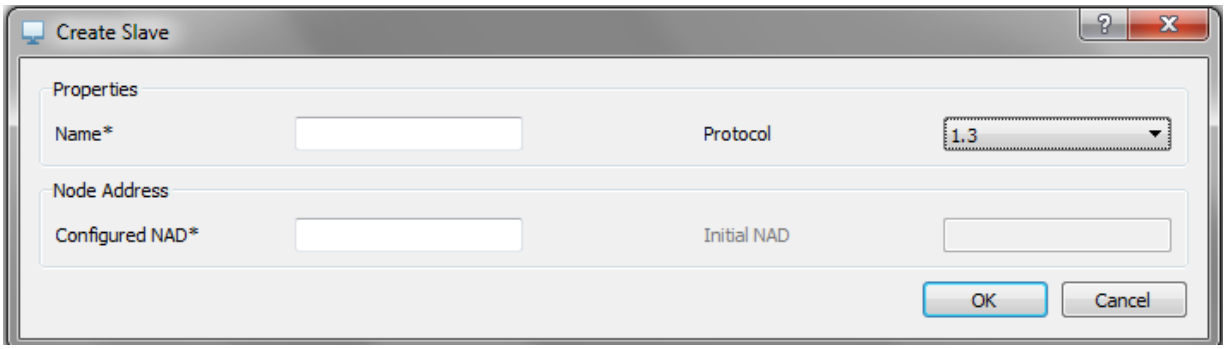
Slave

Creating Slave:

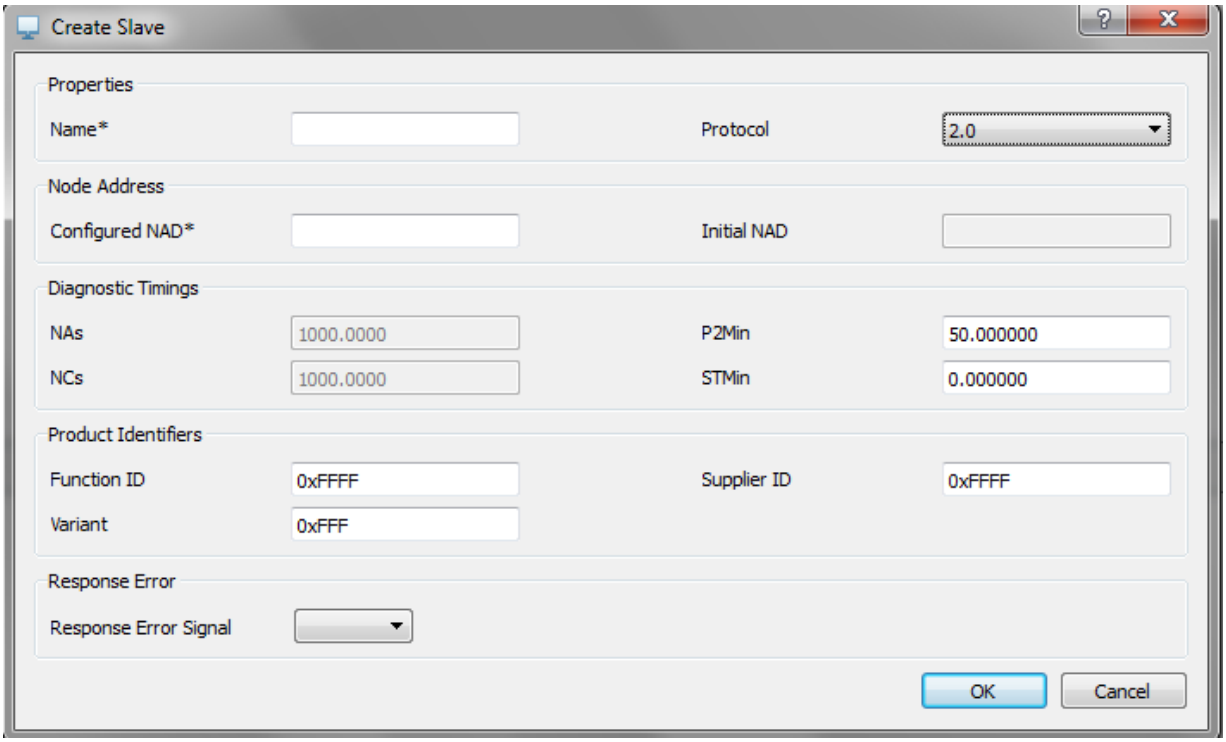
To create or edit slave nodes right click on the 'Slaves' element in the Element View. By default one slave will be created on creating new LDF file. 'Create Slave Dialog' is as shown below.

Slave can be created with the following Slave Protocol versions, Properties displayed will vary based on the protocol version selected

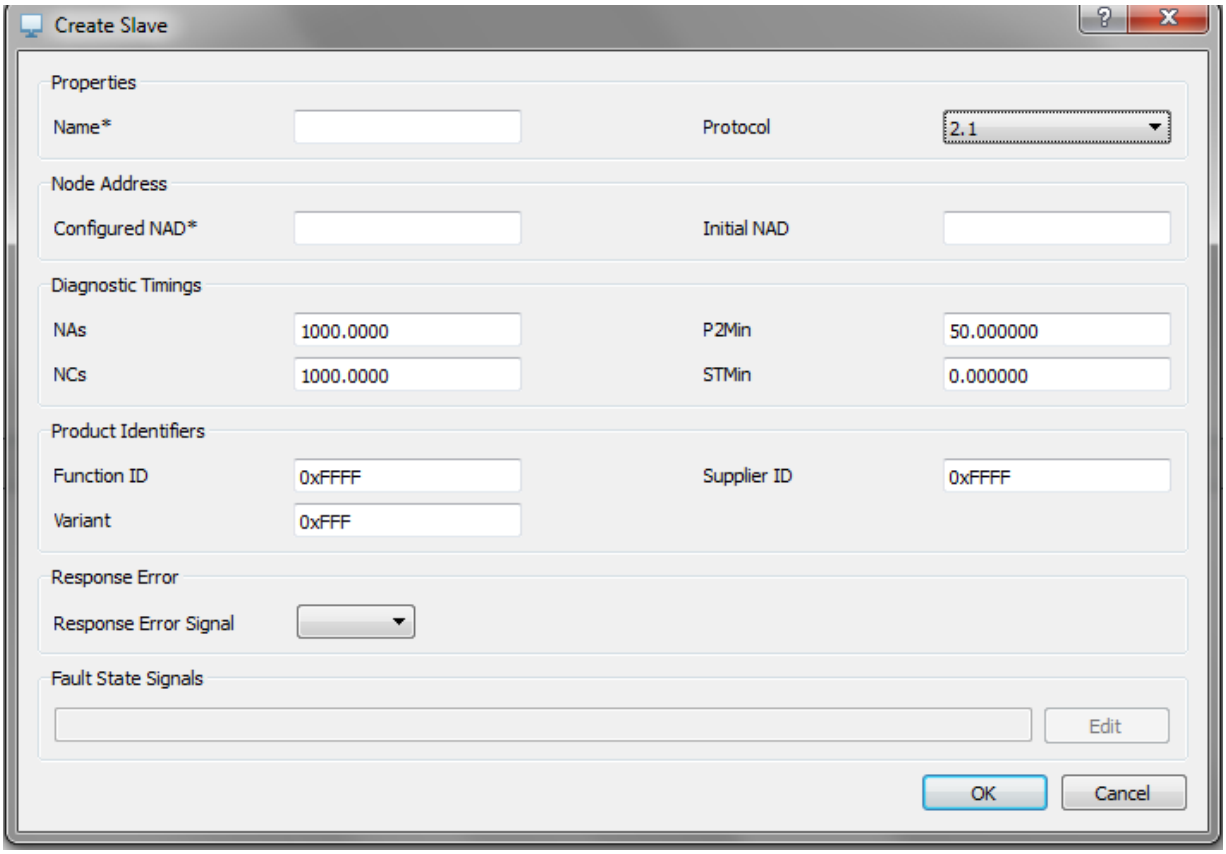
- Slave created with the protocol version 1.3 is as shown below



- Slave created with the protocol version 2.0 is as shown below

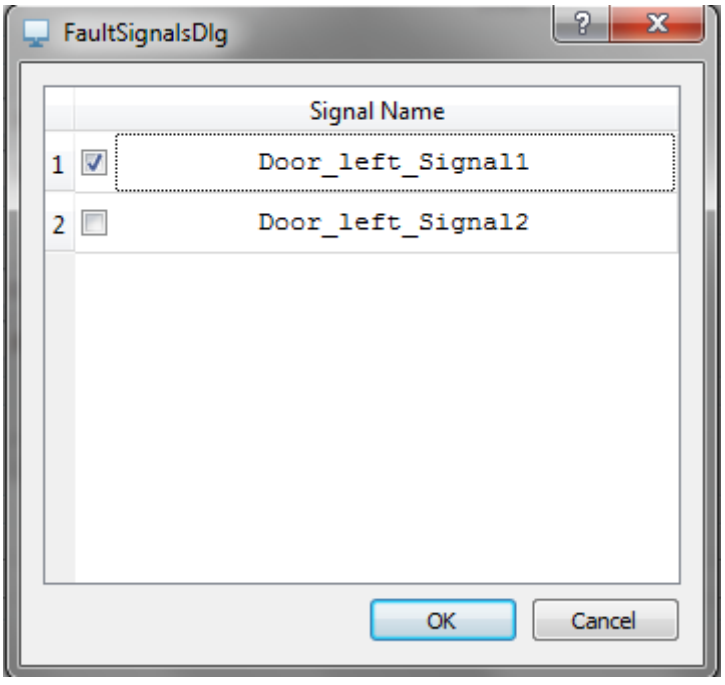


- Slave created with the protocol version 2.1 is as shown below



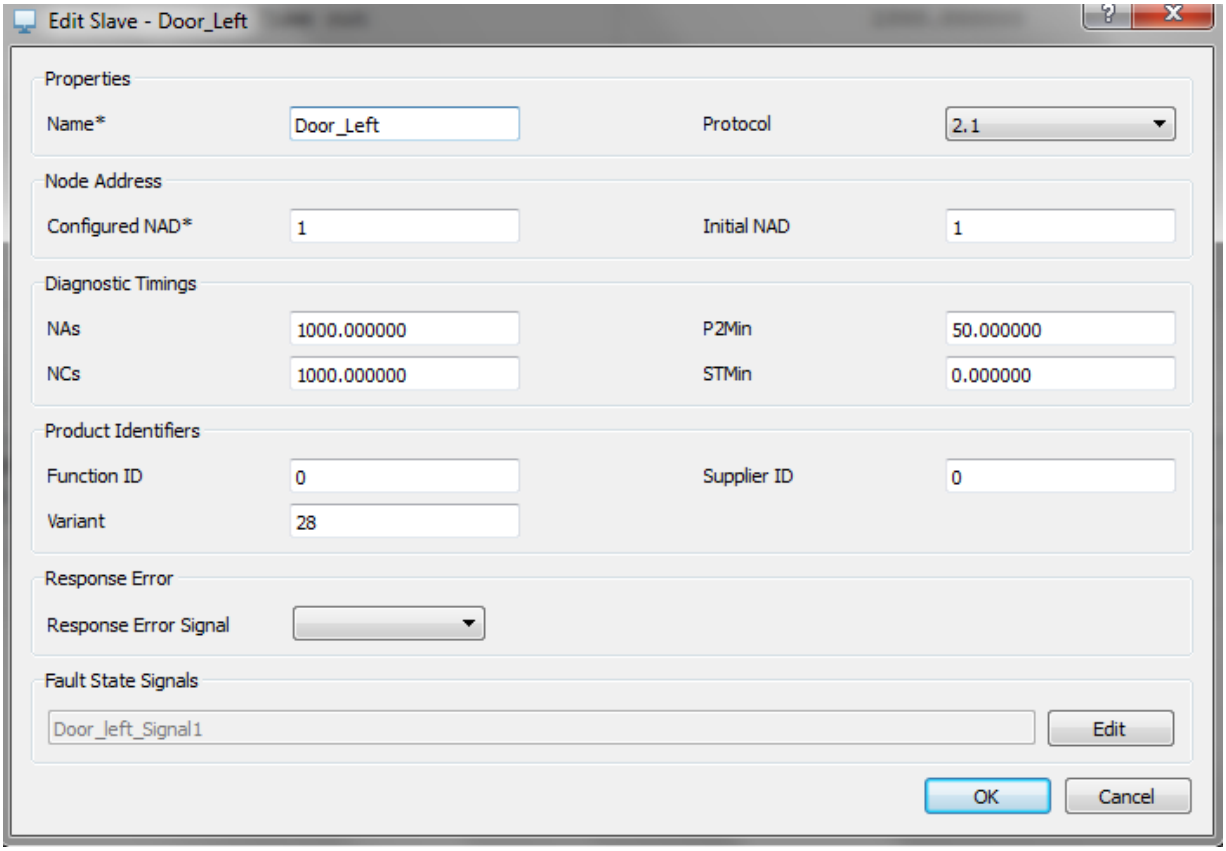
General Properties:

- **Name:** Name of the Slave which should follow C identifier rules and should be unique.
- **Protocol Version:**
  1. For LDF Version 2.1, Protocol version drop down will be populated with 1.3,2.0 and 2.1
  2. For LDF Version 2.0, Protocol version drop down will be populated with 1.3 and 2.0
  3. For LDF Version 1.3, Protocol version drop down will be populated with 1.3
- **Response Error Signal:** Response Error Signal drop down will be populated with the list of signals existing in the configuration. Response Error Signal is displayed if the Slave protocol versions 2.0 and 2.1
- **Fault State Signals:** To specify fault state signals, click on 'Edit' button which displays



Editing Slave:

To Edit the existing Slave node, right click on the Slave in the Element View and select popup menu 'Edit' which displays



Deleting Slave:

To delete Slave node, right click on the Slave node in the Element View and select pop up menu 'Delete'. Confirmation message will be displayed before deleting the Node.

On deleting node, all the frames and signals published by the node will also be deleted.

To save the changes click on 'OK' button. Errors are displayed if validation fails.

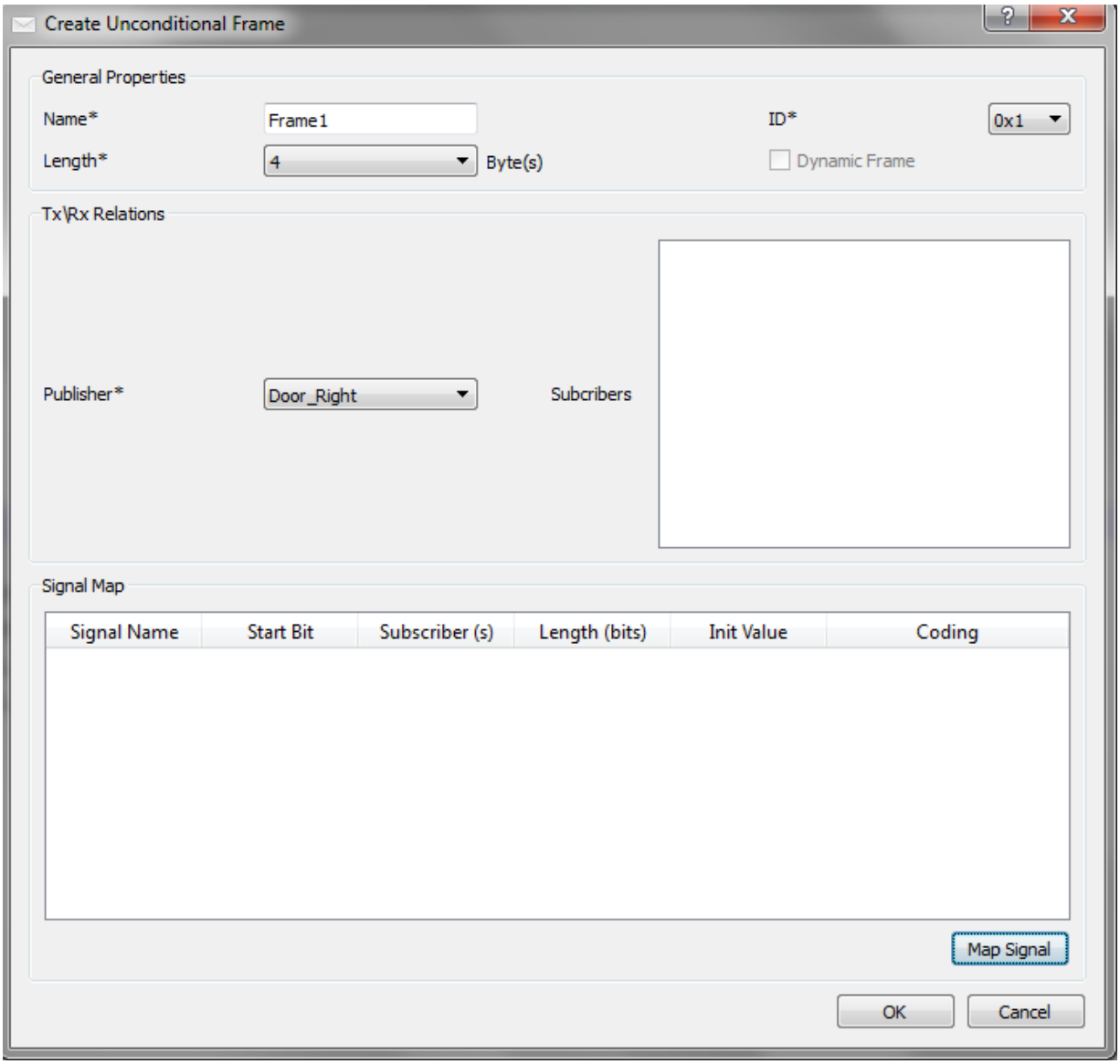
The following validations are performed:

- Slave name will be checked for its uniqueness
- On delete, checks if at least one Slave node is available. If not tool will give error.

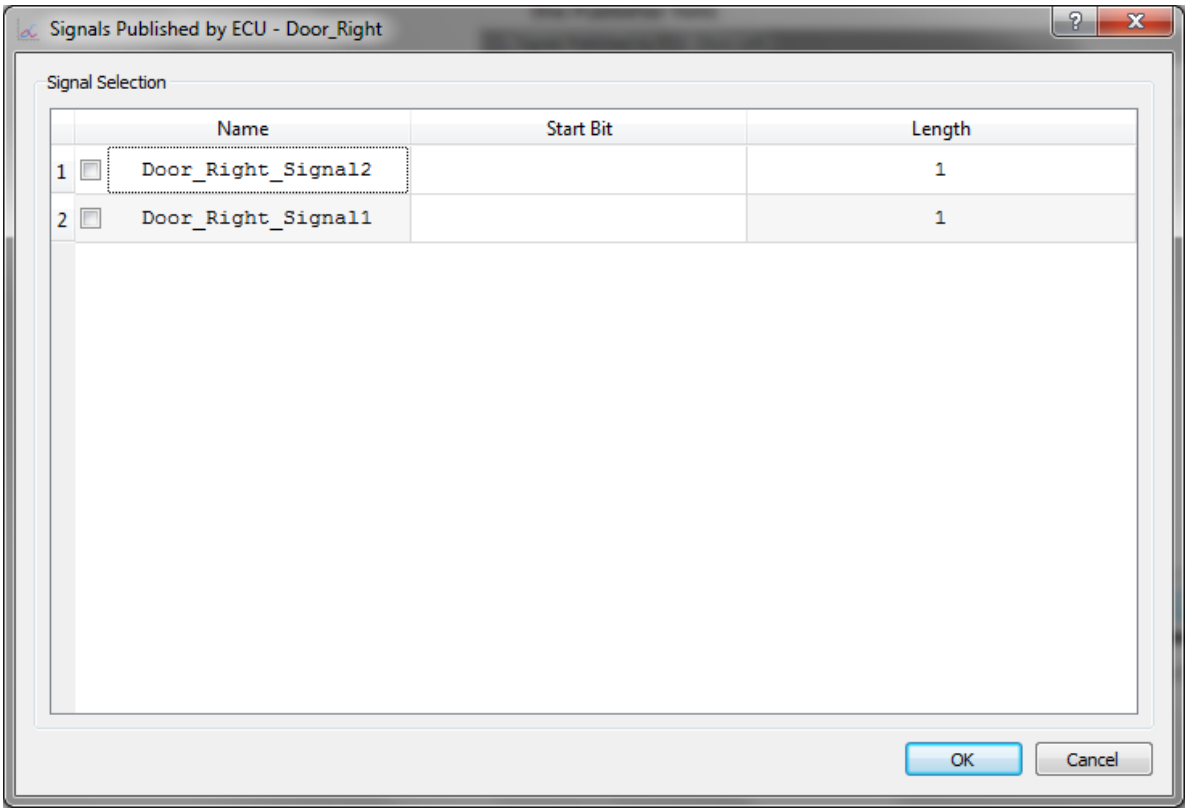
Unconditional Frame

Creating Unconditional Frames:

To create Unconditional frame right click on the Unconditional Frame element in the element view and click on popup menu 'New'. 'Create Unconditional Frame' dialog is shown as below.



1. **General Properties:**
   - **Name:** Name of the frame should follow C identifier rules and should be unique.
   - **ID:** Identifier of the frame [0-59]
   - **Length:** Length of the frame [1-8] in bytes
   - **Dynamic Frame**: If dynamic frame, the 'Dynamic Frame' check box should be checked. More than one Unconditional frame can exist with the same Id and it is introduced from LDF version 2.0.
2. **Publisher and Subscribers:**
   - Frame publisher can be selected from the Publisher drop down which lists Master and Slave nodes
   - Subscribers list is read only and will get populated on mapping signals using 'Map Signal' button
3. **Signal Mapping:**
   - To map signals to the frame click on 'Map Signal' button. Map Signal dialog is displayed as shown below with lists signals thats belong to the publisher selected in the Publisher field.



To save the changes click on 'OK' button. Errors are displayed if validation fails.

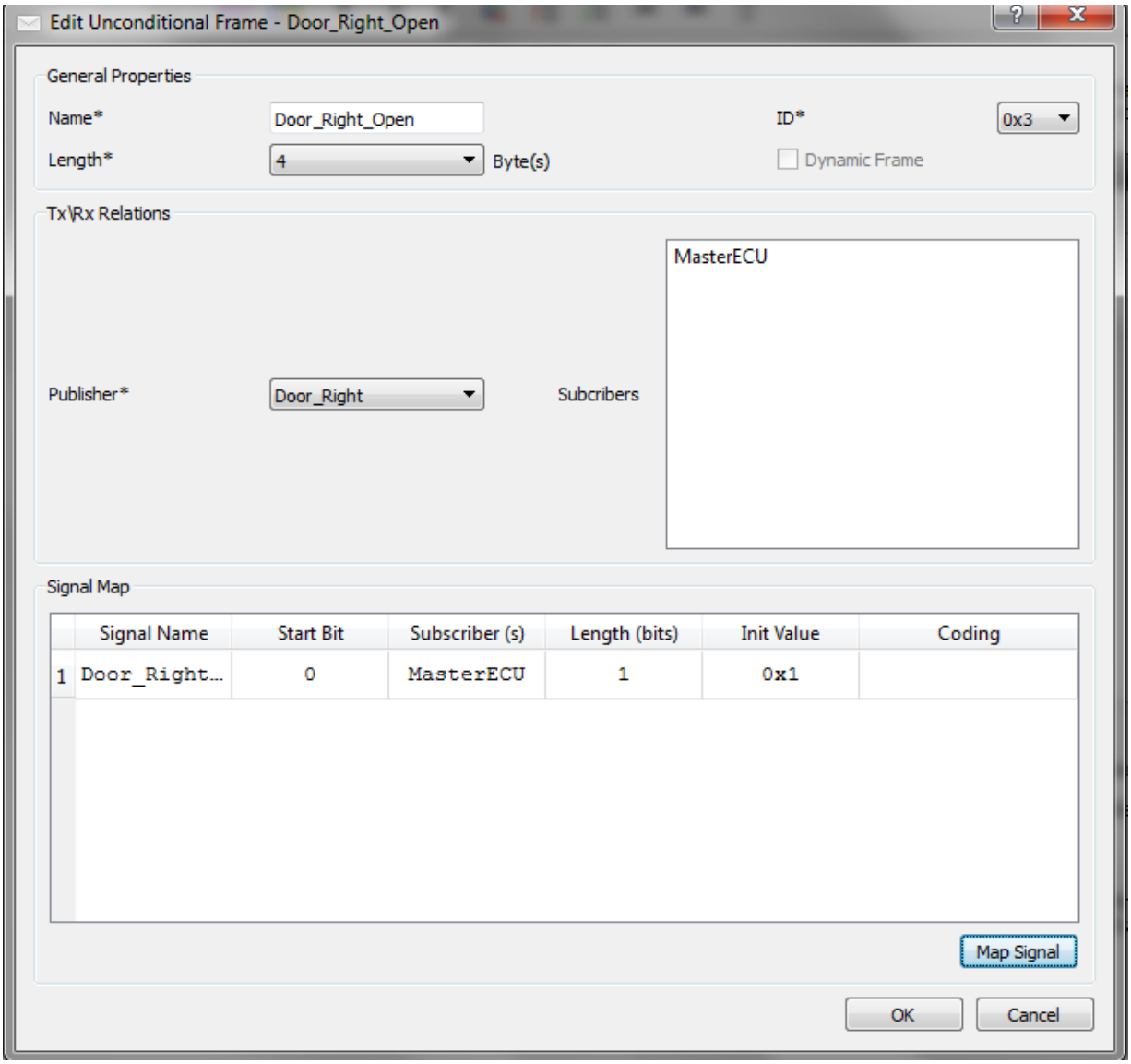
The following validations are performed:

- Frame name will be checked for its uniqueness
- If the frame is not dynamic frame, Frame Id will be checked for uniqueness

To discard the changes click on 'Cancel' button.

Editing Unconditional Frames:

To edit existing Unconditional Frame right click on the Unconditional frame item in the Element view and click on 'Edit'. 'Edit Unconditional Frame' dialog is displayed as shown below.



Deleting Unconditional Frame:

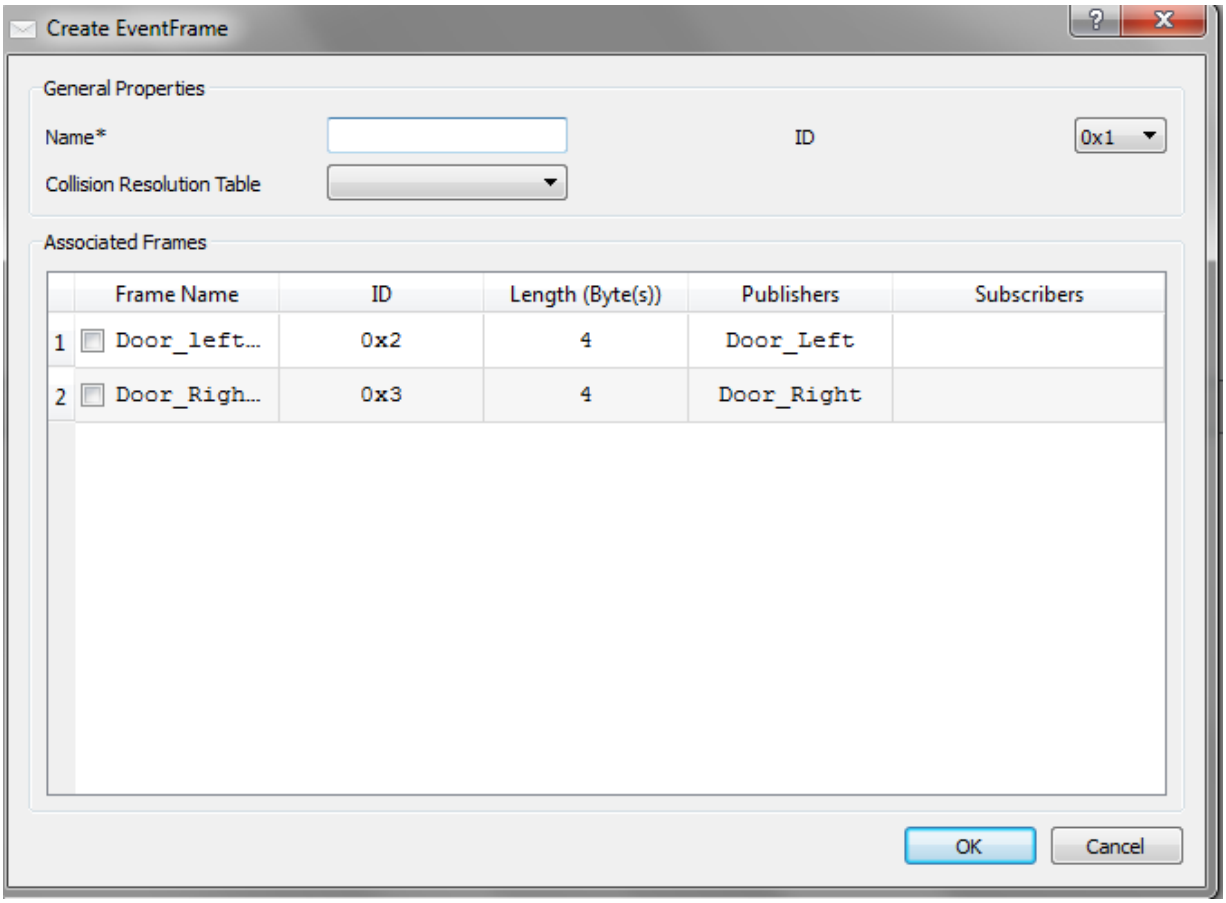
To delete Unconditional Frame, right click on the Unconditional frame item in the Element view and click on the popup menu 'Delete'. A confirmation message will be displayed before deleting the frame.

On deletion, deleted Unconditional frame will be unmapped from the Publisher and the Subscribers.

Event Triggered Frame

Creating Event Triggered Frames:

To create Event Triggered frame right click on the Event Triggered Frame element in the element view and click on popup menu 'New'.Create Event Triggered Frame dialog is as shown below.



1. **General Properties:**
   - **Name:** Name of the frame which should follow C identifier rules and should be unique.
   - **ID:** Identifier of the frame [0-59]
   - **Collision Resolution Table:** Using drop down select the Schedule table to be referred in case of Collision.
2. **Associating Frames:**
   - Check the Unconditional frames to be mapped to the Event Triggered frame from the Associated Frames list.

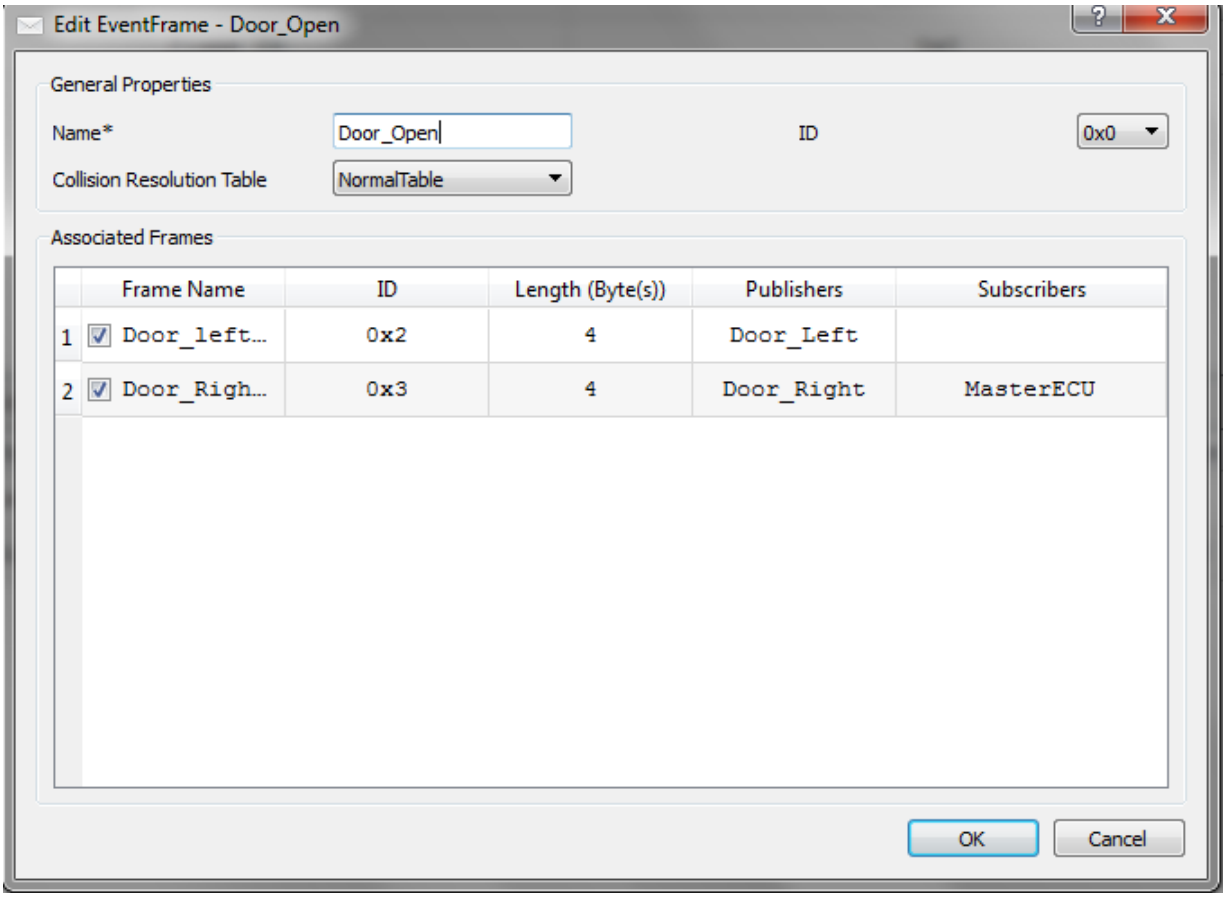
The following validations are performed:

- Frame name will be checked for its uniqueness
- Frame Id will be checked for its uniqueness
- Checked if selected Associated frames belong to the Collision resolving table

To discard the changes click on 'Cancel' button.

Editing Event Triggered Frames:

To edit existing Event Triggered Frame right click on the Event Triggered frame item in the Element view and click on 'Edit'. 'Edit Event Triggered Frame' dialog is displayed as shown below.



Deleting Event Triggered Frame:

To delete Event Triggered Frame, right click on the Event Triggered frame item in the Element view and click on the pop up menu 'Delete'. A confirmation message will be displayed before deleting the frame.

To save the changes click on 'OK' button. Errors are displayed if validation fails.

The following validations are performed:

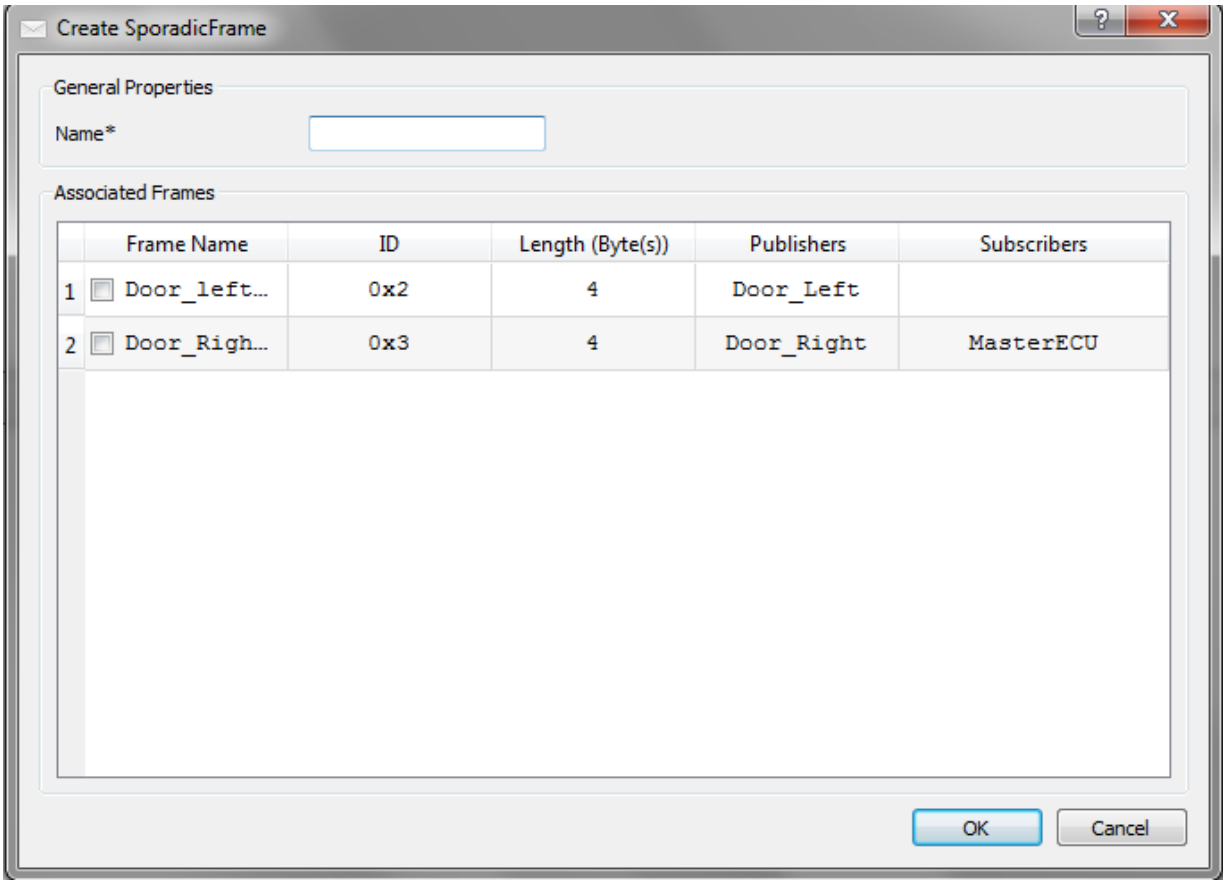
- Frame name will be checked for its uniqueness
- Frame Id will be checked for its uniqueness
- Checked if selected Associated frames belong to the Collision resolving table

To discard the changes click on 'Cancel' button.

Sporadic Frame

Creating Sporadic Frames:

To create Sporadic frame right click on the Sporadic Frame element in the element view and click on popup menu 'New'.'Create Sporadic Frame' dialog is as shown below.



1. **General Properties:**
   - **Name:** Name of the frame which should be follow C identifier rules and should be unique.
2. **Associating Frames:**
   - Check the Unconditional frames to be mapped to the Sporadic frame from the Associated Frames list.

To save the changes click on 'OK' button. Errors are displayed if validation fails.

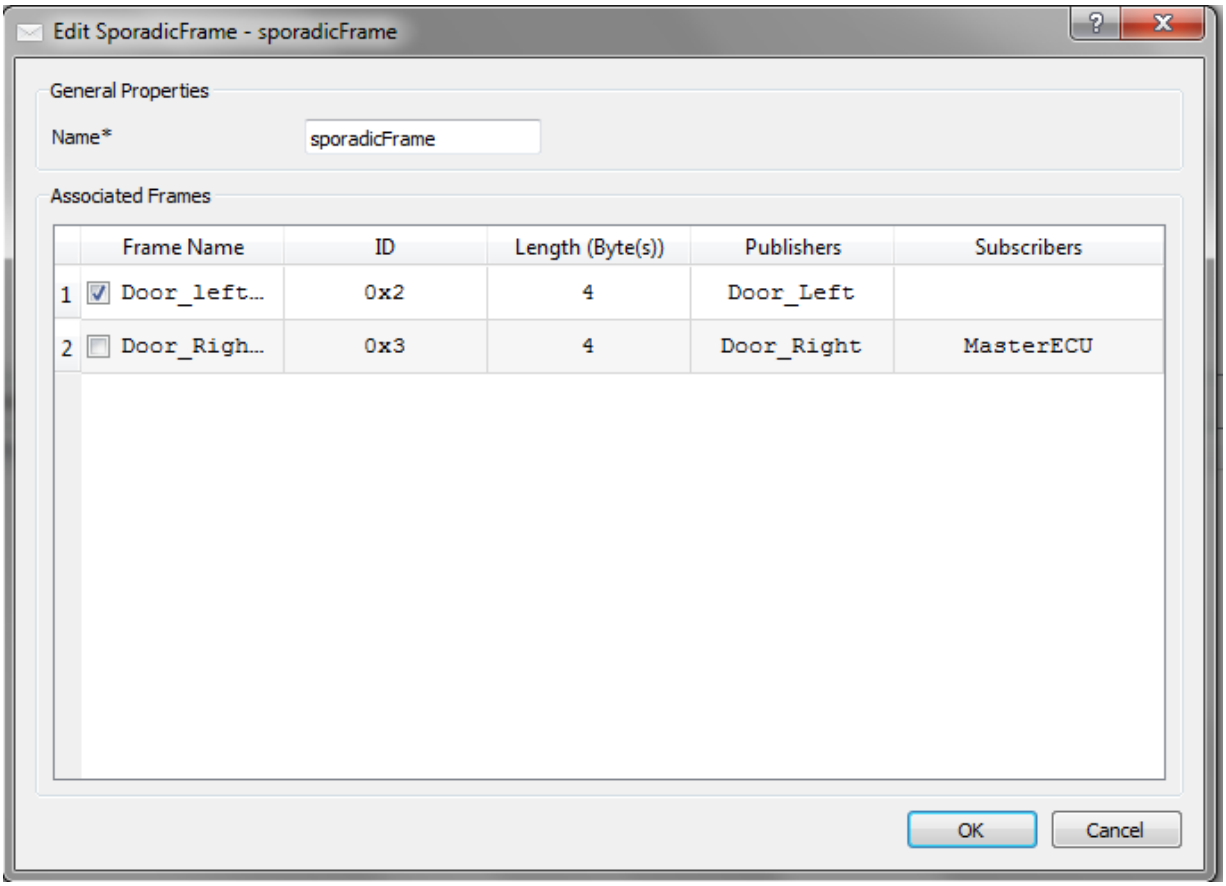
The following validations are performed:

- Frame name will be checked for its uniqueness

To discard the changes click on 'Cancel' button.

Editing Sporadic Frames:

To edit existing Sporadic Frame right click on the Sporadic frame item in the Element view and click on 'Edit'. 'Edit Sporadic Frame' dialog is displayed as shown below.



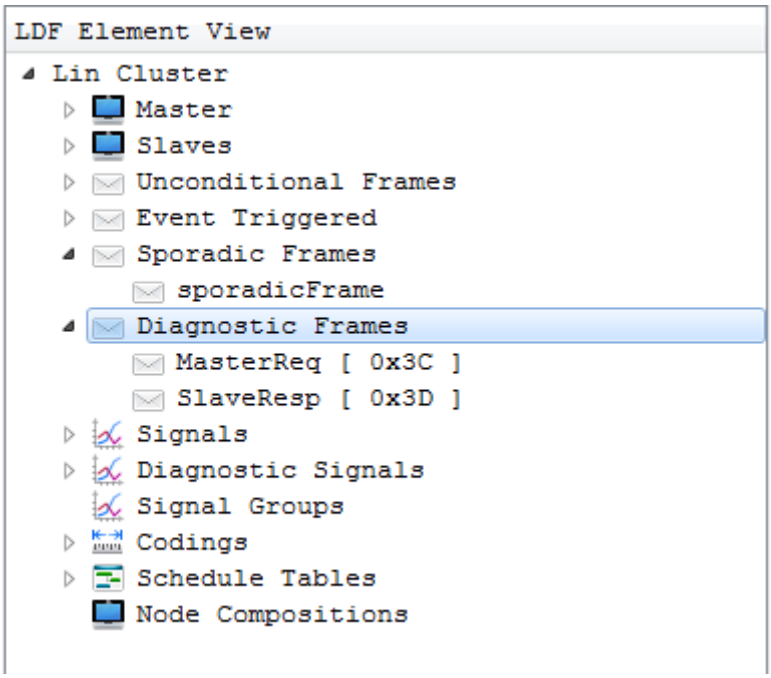
Deleting Sporadic Frame:

To delete Sporadic Frame, right click on the Sporadic item in the Element view and click on the popup menu 'Delete'. A confirmation message will be displayed before deleting the frame.

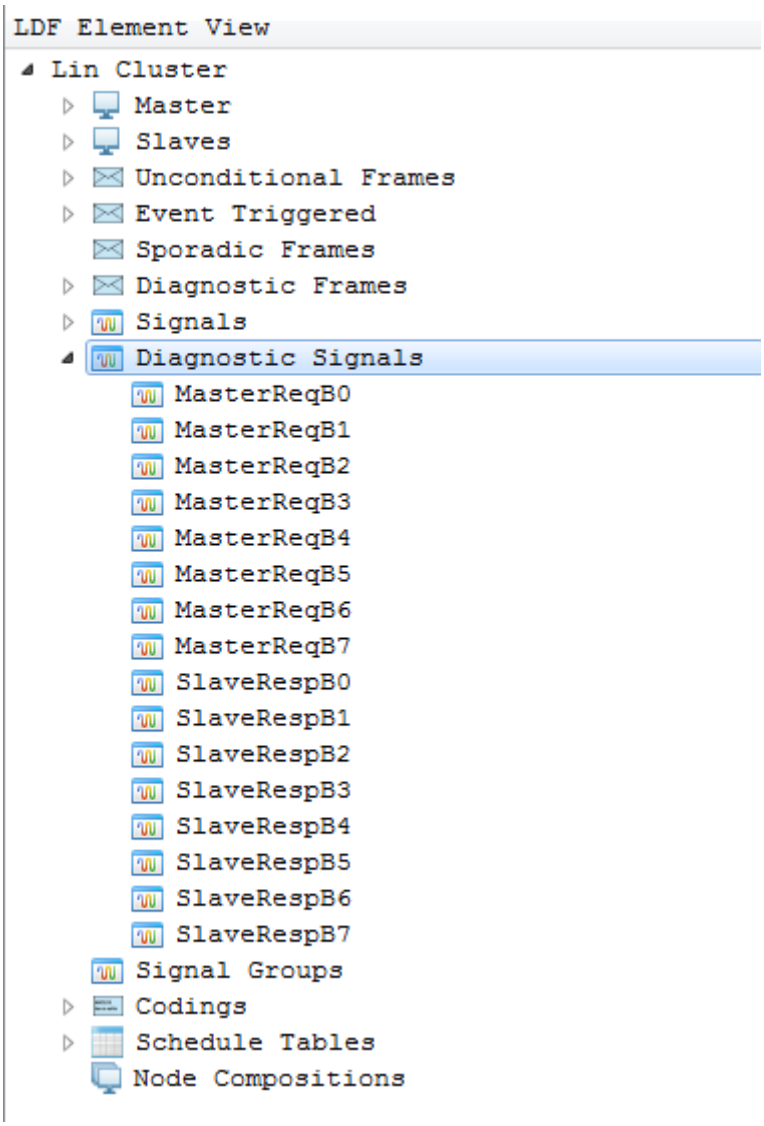
Diagnostic Support

Adding Diagnostic Support:

To create diagnostic frames, right click on the 'Diagnostic Frames' element in the Element view. By default 'MasterReq' and 'SlaveResp' diagnostic frames will get created as shown below.



On Adding diagnostic support for Frame, Diagnostic Signals will get automatically created for Master and Slave under 'Diagnostic Signals' in the Element View as shown below.



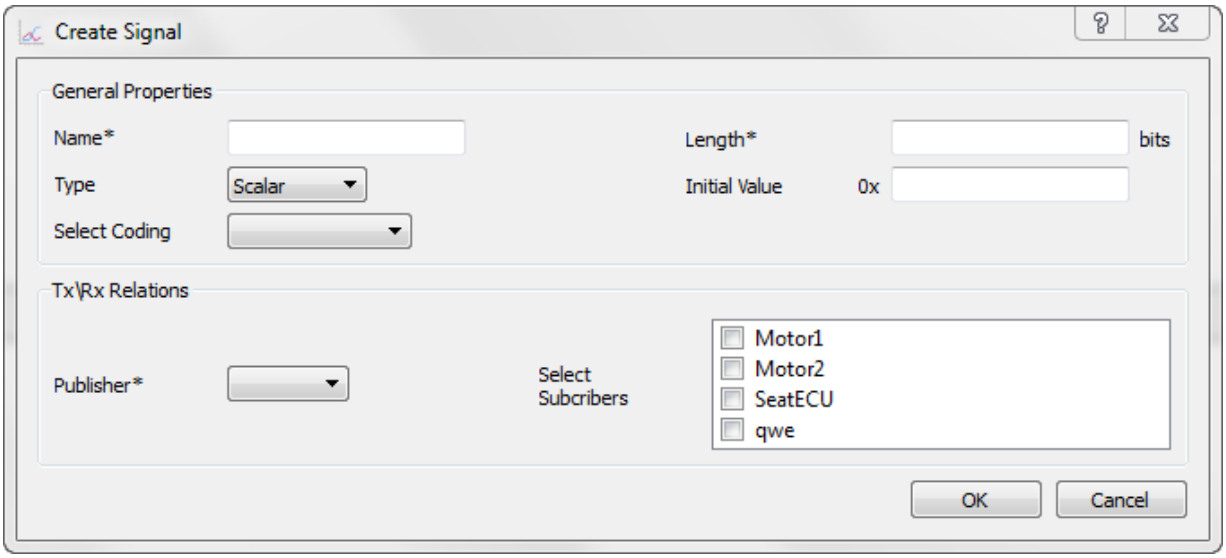
Removing Diagnostic Support:

To remove diagnostic support right click on 'Diagnostic Frames' in the Element view and click on 'Remove Diagnostic Support' which removes diagnostic frames and diagnostic signals.

Signals

Creating Signals:

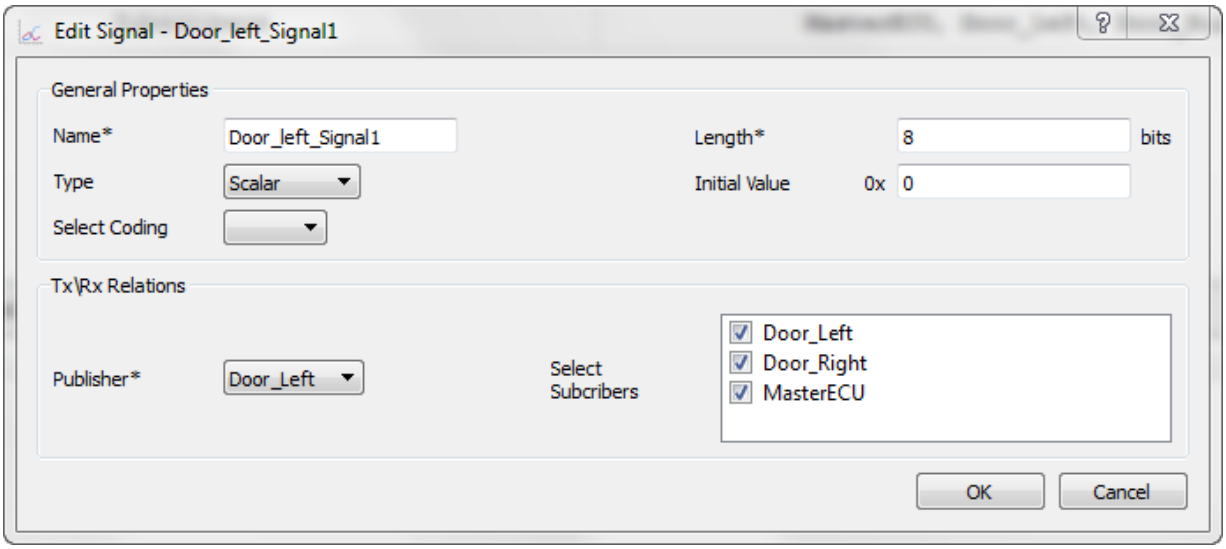
To create Signals right click on the **Signals** element in the element view and click on pop up menu '*New*'.A dialog Box as Shown in below image will be displayed.



1. **General Properties:**
   - **Name:** Name of the Signal should follow C identifier rules and should be unique in signal list.
   - **Length:** Length of the Signals in bits.The value always will be displayed as Decimal mode
   - **Type**: Signal type can be either scalar or Byte array.
   - **Initial Value:** This will be the initial value of the signal.
   - **Coding:** Coding for the signal can be selected from the drop down **Select Coding**, which lists all the defined Codings.To define new coding refer the section Codings.
2. **Publisher and Subscribers:**
   - Signal publisher can be selected from the **Publisher** drop down which lists Master and all the Slave nodes
   - Subscribers of the signals can be selected from the **Select Subscribers** list.

Editing Signals:

To edit existing Signal right click on the required signal item in the Element view and click on 'Edit'. **Edit Signal - <*Signal Name*>** dialog is displayed as shown below.



If the publisher is changed, the signal will be unmapped from the frames which are published by the old ECU.

To save the changes click on 'OK' button. Errors are displayed if validation fails.

The following validations are performed:

- Signal name will be checked for its uniqueness
- Initial value should be in range of 0 (to 2^signal_length-1)

- A Publisher should be selected.

To discard the changes click on 'Cancel' button.

Deleting Signal:

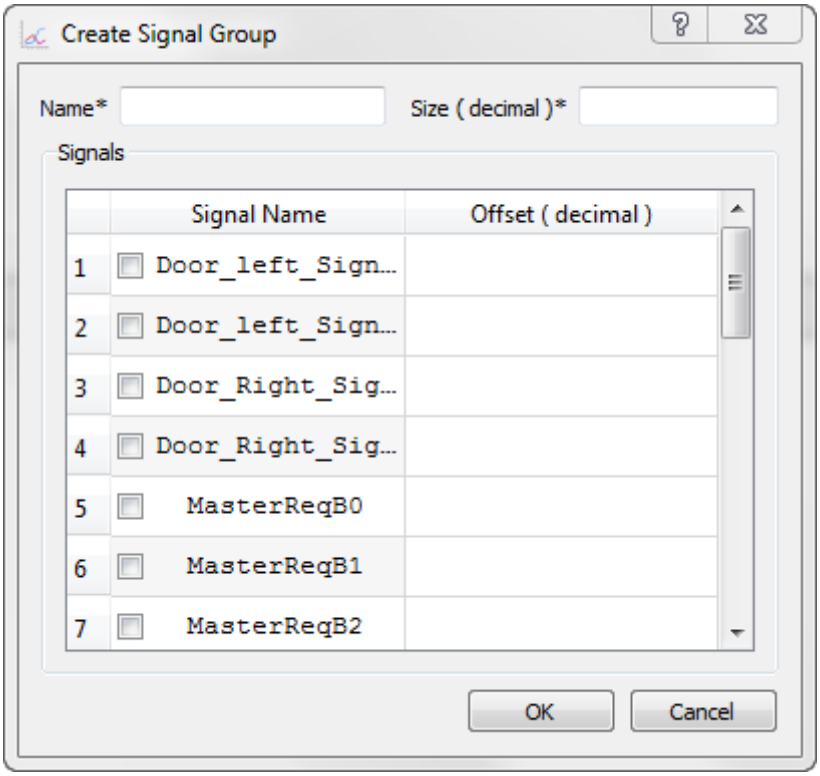
To delete any signal, right click on the Signal item in the Element view and click on the pop up menu **Delete**. A confirmation message will be displayed before deleting the signal.

On deletion, deleted signal will be unmapped from all associated frames, Publisher and the Subscribers.

Signal Group

Creating Signal Groups:

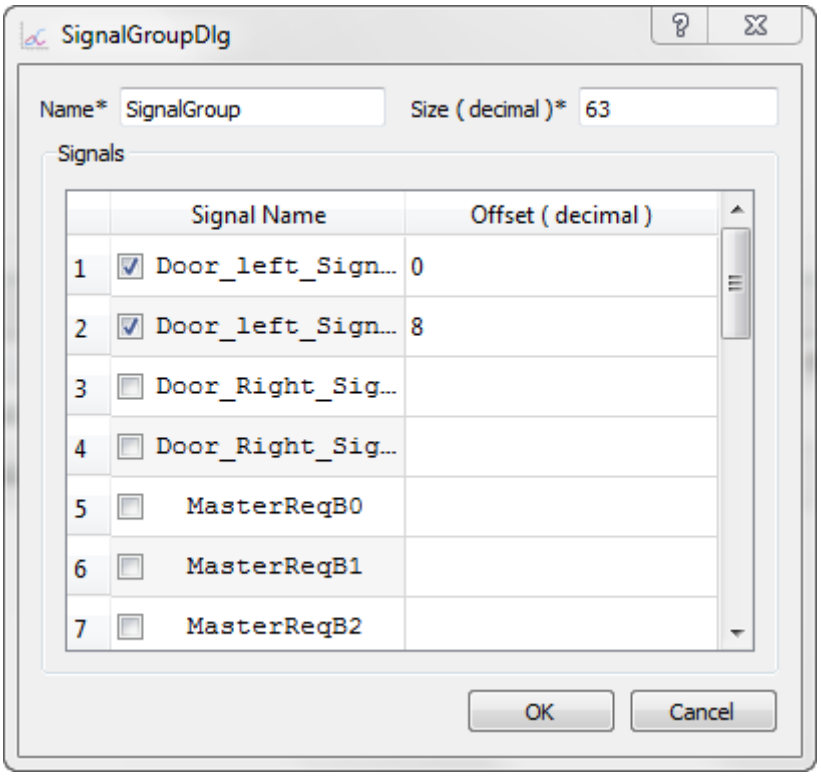
To create Signal group right click on the **Signal Group** element in the element view and click on pop up menu '*New*'.A dialog Box as Shown in below image will be displayed.



1. **General Properties:**
   - **Name:** Name of the Signal Group should follow C identifier rules and should be unique in Signal and Signal Group List.
   - **Size:** The size of the signal group can be defined here.
2. **Signals:**
   - This list the all the signal defined in the LIN Cluster.Signals can be added\deleted from the group by checking\ unchecking.

Editing Signal Group:

To edit existing Signal group right click on the required Signal group item in the Element view and click on 'Edit'. **Edit Signal - <Signal Group Name>** dialog will be displayed as shown below.



Signals can be added\deleted from the group by checking\ unchecking corresponding check box.The signal offset can be changed in the Offset filled.

To save the changes click on 'OK' button. Errors are displayed if validation fails.

The following validations are performed:

- Signal group name will be checked for its uniqueness.
- The offset of each signal should be less than the Signal Group size.

To discard the changes click on 'Cancel' button.

Deleting Signal Group:

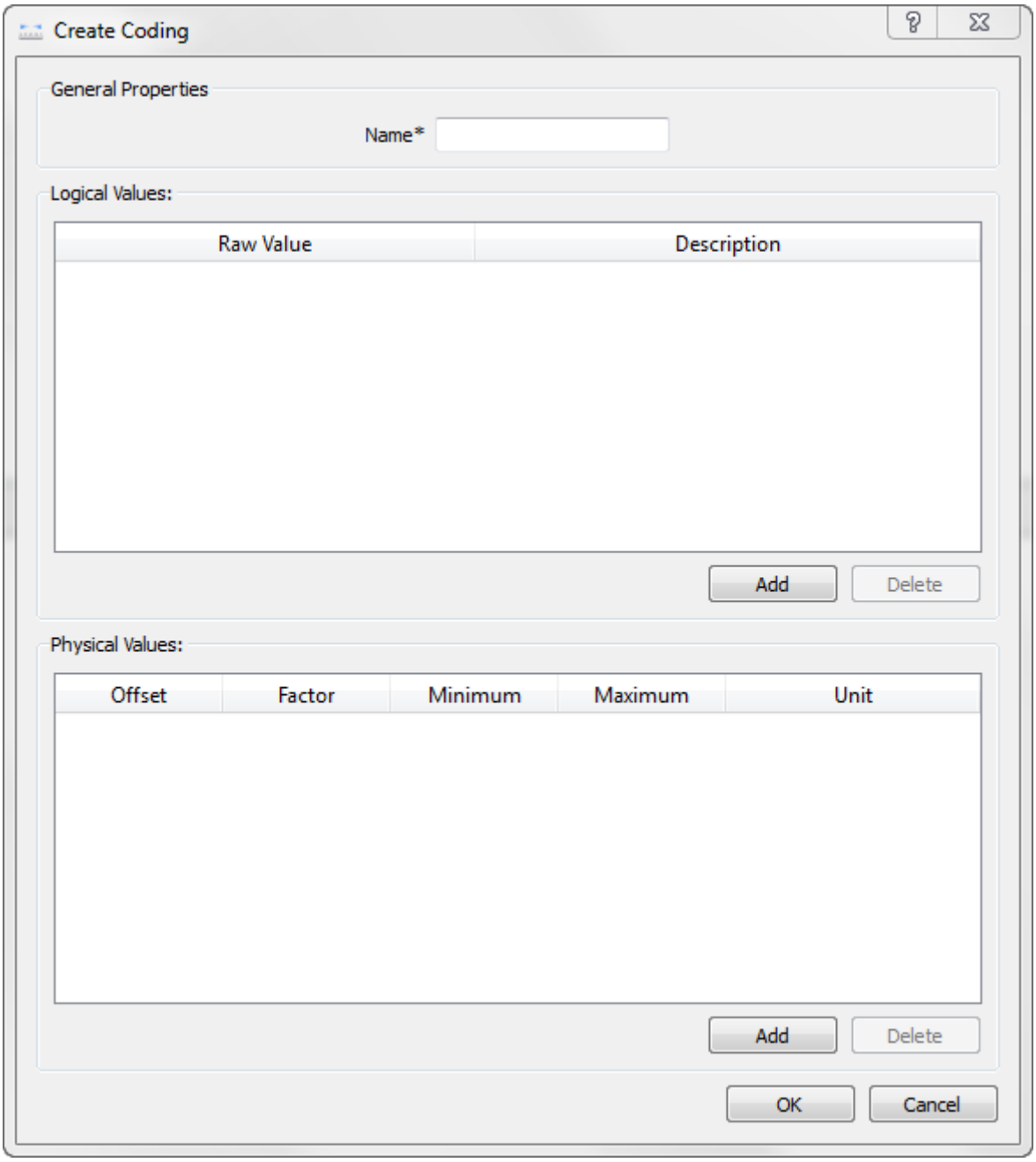
To delete any signal group, right click on the signal group item in the Element view and click on the pop up menu **Delete**. A confirmation message will be displayed before deleting the coding.

Note: Signal groups are depreciated from LDF2.x version.

Codings

Creating Codings:

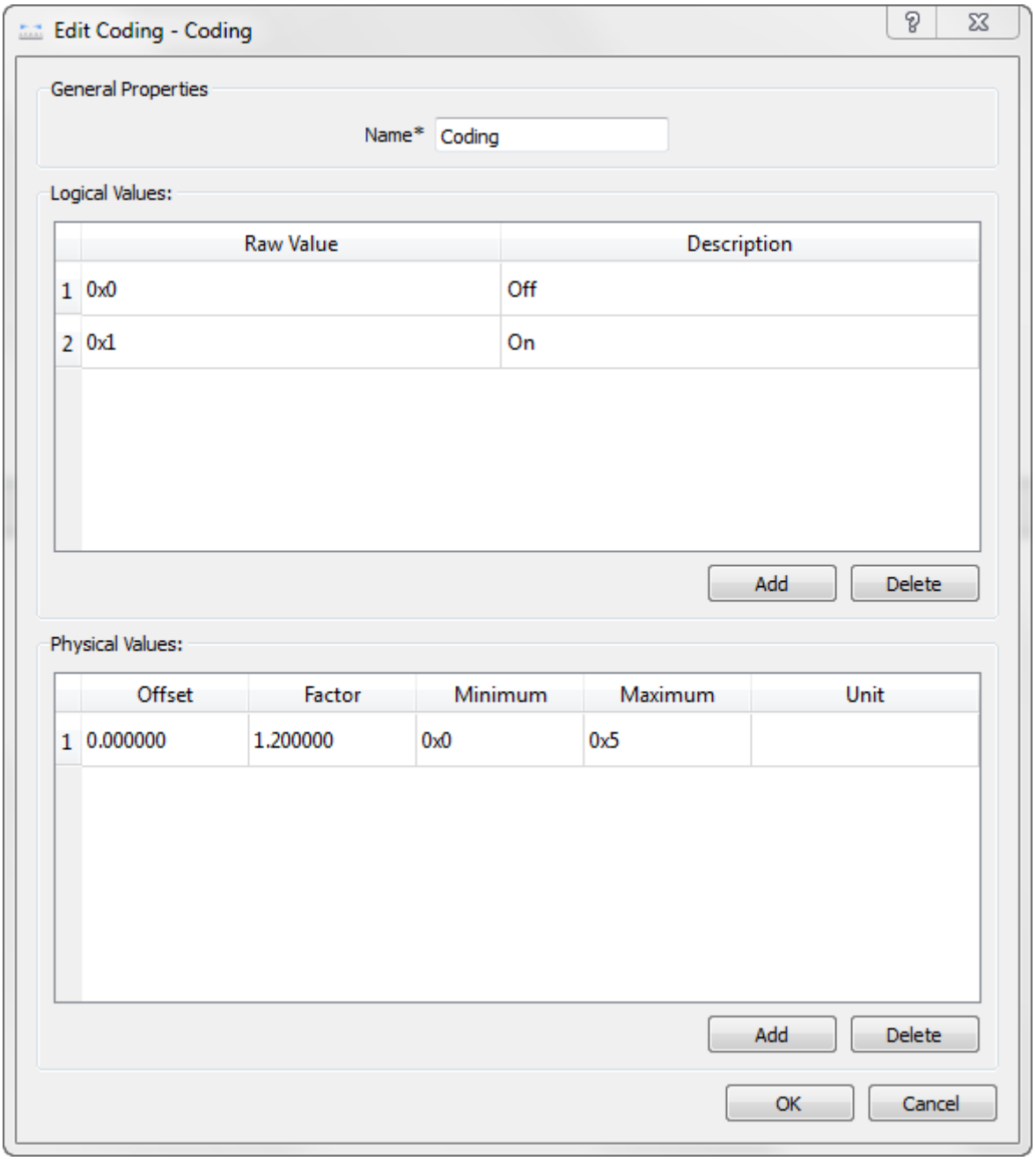
To create Codings right click on the Codings element in the element view and click on pop up menu '*New*'.A dialog Box as Shown in below image will be displayed.



1. **General Properties:**
   - **Name:** Name of the Coding should follow C identifier rules and should be unique in coding list.
2. Logical values and physical values can be created using Add Buttons provided in the corresponding sections.

Editing Codings:

To edit existing Coding right click on the required coding item in the Element view and click on 'Edit'. **Edit Coding - <*Coding Name*>** dialog will be displayed as shown below.All The values are editable



To delete a logical element select the logical row and click on the Delete button provided in the same section.Similarly Physical values also can be deleted using the delete button provided in the same section.

To save the changes click on 'OK' button. Errors are displayed if validation fails.

The following validations are performed:

- Coding name will be checked for its uniqueness

To discard the changes click on 'Cancel' button.

Deleting Coding:

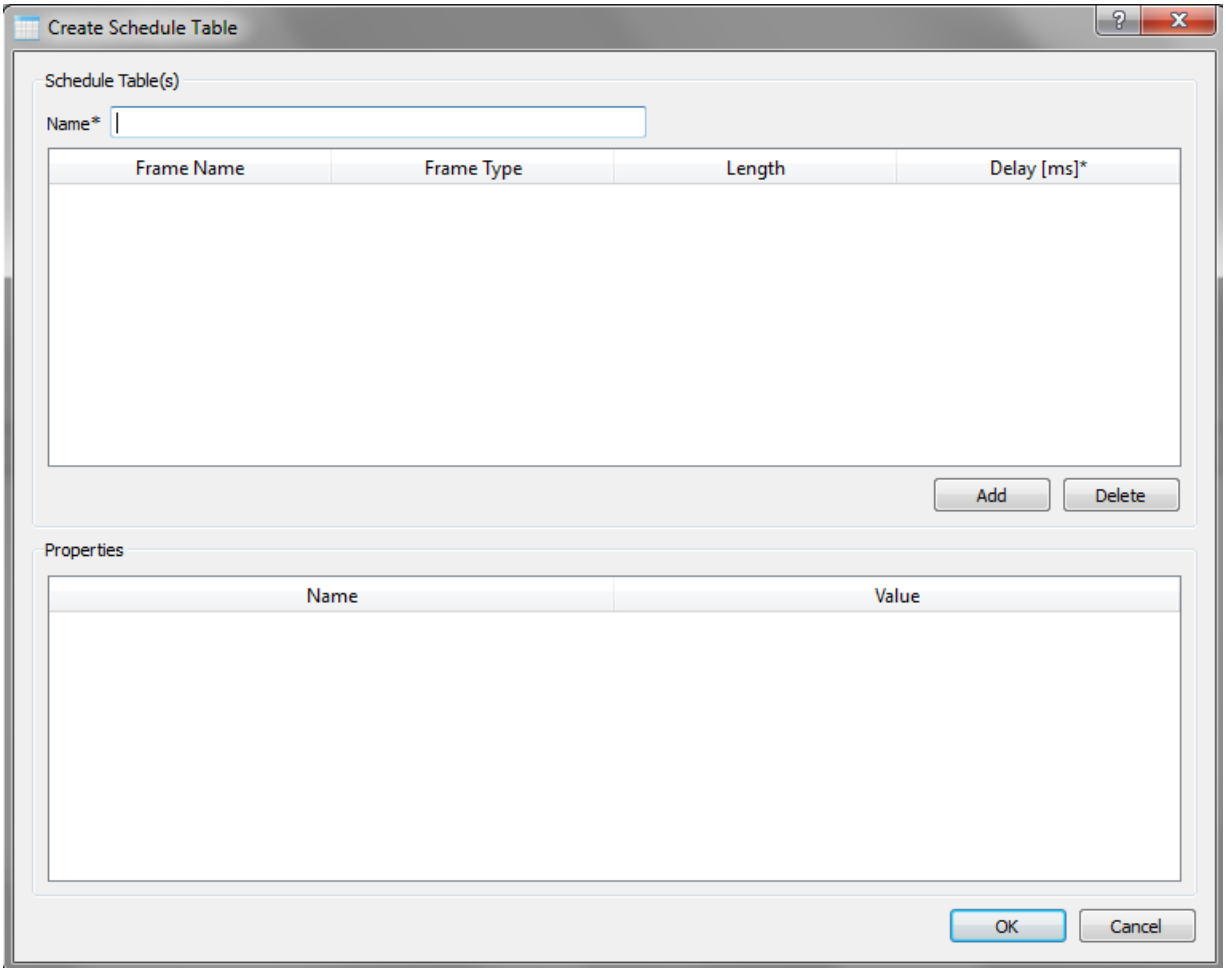
To delete any coding, right click on the coding item in the Element view and click on the pop up menu **Delete**. A confirmation message will be displayed before deleting the coding.

On deletion, coding will be unmapped from all associated signals.

Schedule Table

Creating Schedule Table:

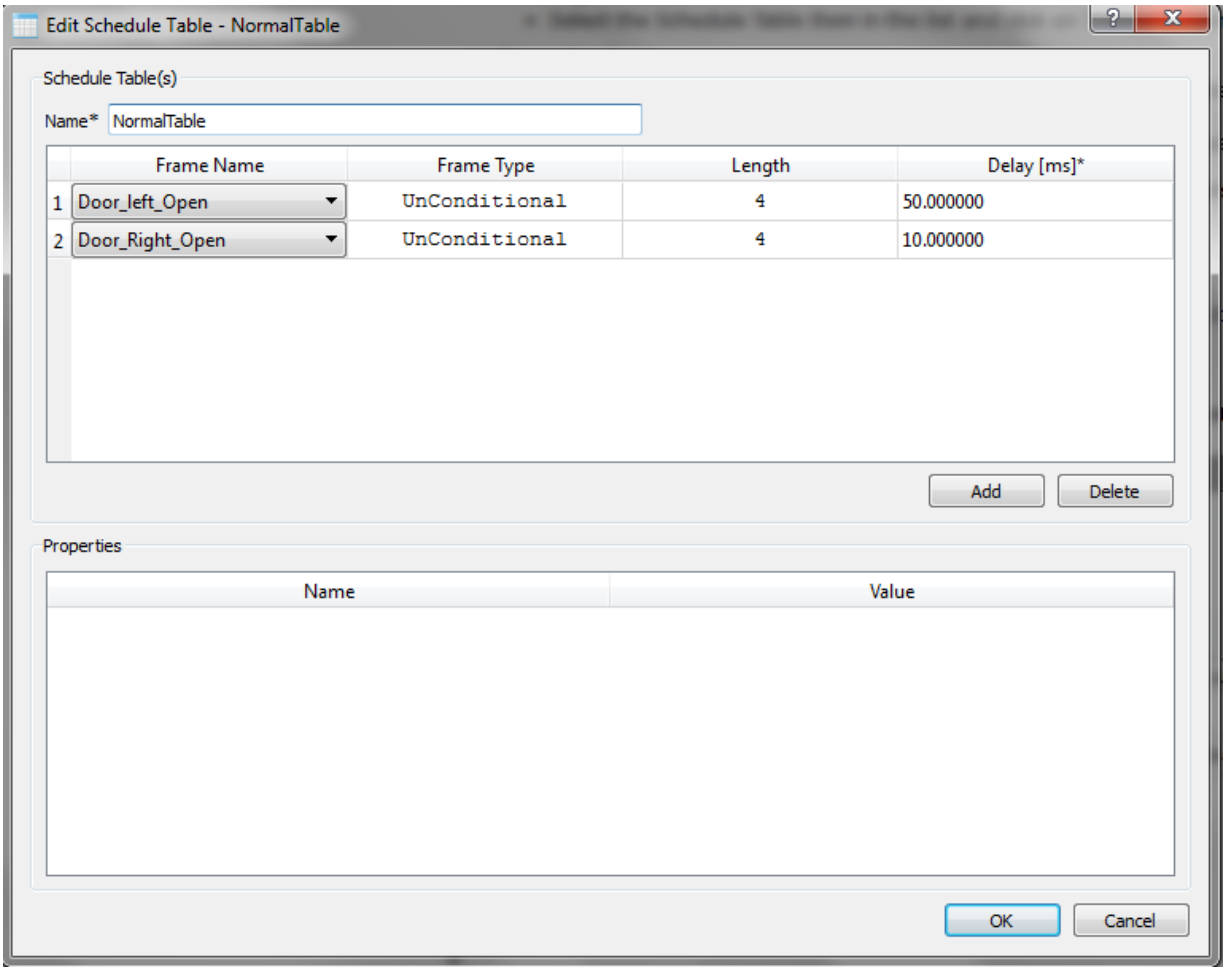
To create Schedule Table right click on the Schedule Table element in the element view and click on popup menu 'New'.Create Schedule Table dialog is as shown below.



1. **General Properties:**
   - **Name:** Name of the Schedule Table should follow C identifier rules and should be unique.
2. **Adding Schedule Table Item:**
   - To Add Schedule Table Item, click on 'Add' button which adds a new row in Frame list.
   - Frame Name drop down will be populated with the list of Unconditional frames, Event Triggered frames, Sporadic frame and Diagnostic Frames.
   - Select the Frame name from the Frame Name drop down.
   - Specify the delay in delay field.
3. **Deleting Schedule Table Item:**
   - Select the Schedule Table Item in the list and click on 'Delete' button
4. **Property view:**
   - On selecting Schedule Table Item in the list, properties will be displayed in the property view based on the type of the frame selected
   - User defined parameters will be editable in the Property view for user input

Editing Schedule Table:

To edit existing Schedule Table right click on the Schedule Table in the Element view and click on 'Edit'. 'Edit Schedule Table' dialog is displayed as shown below.



Deleting Schedule Table:

To delete Schedule Table, right click on the Schedule Table in the Element view and click on the popup menu 'Delete'. A confirmation message will be displayed before deleting the frame.

To save the changes click on 'OK' button. Errors are displayed if validation fails.

The following validations are performed:

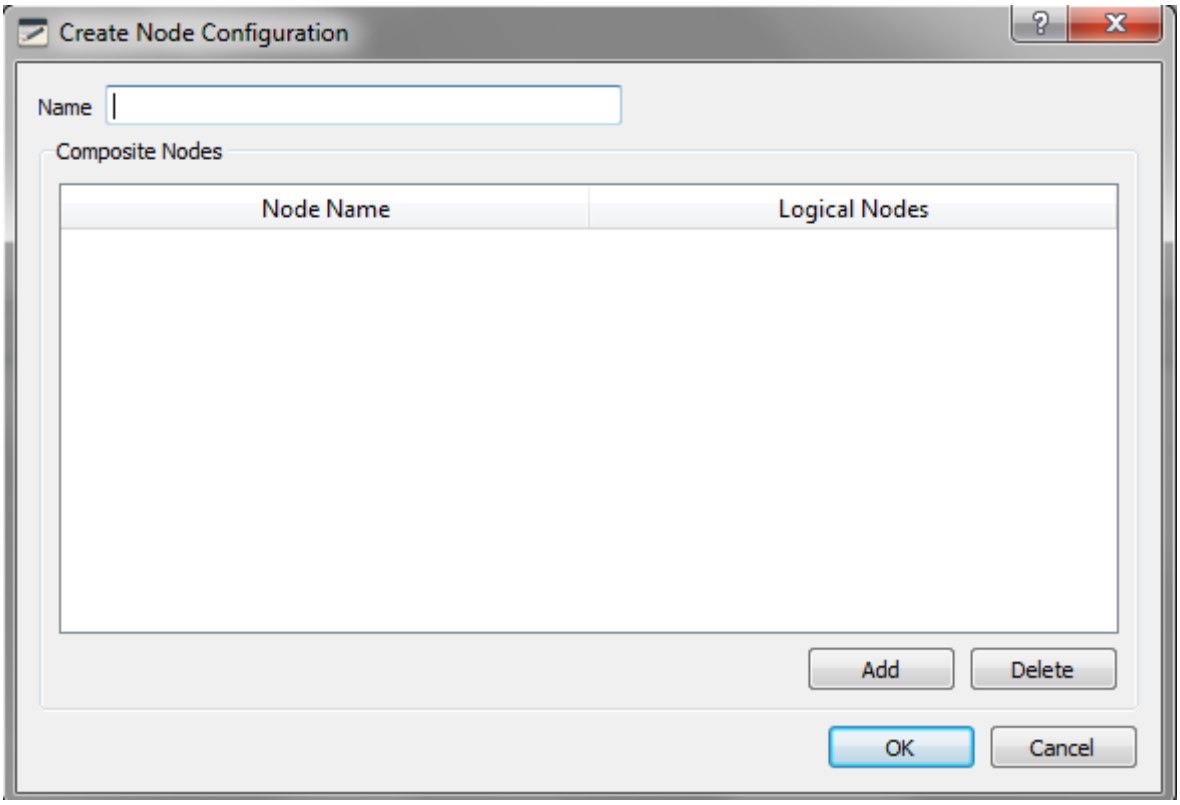
- Schedule Table name will be checked for its uniqueness

To discard the changes click on 'Cancel' button.

Node Composition

Creating Node Compositions:

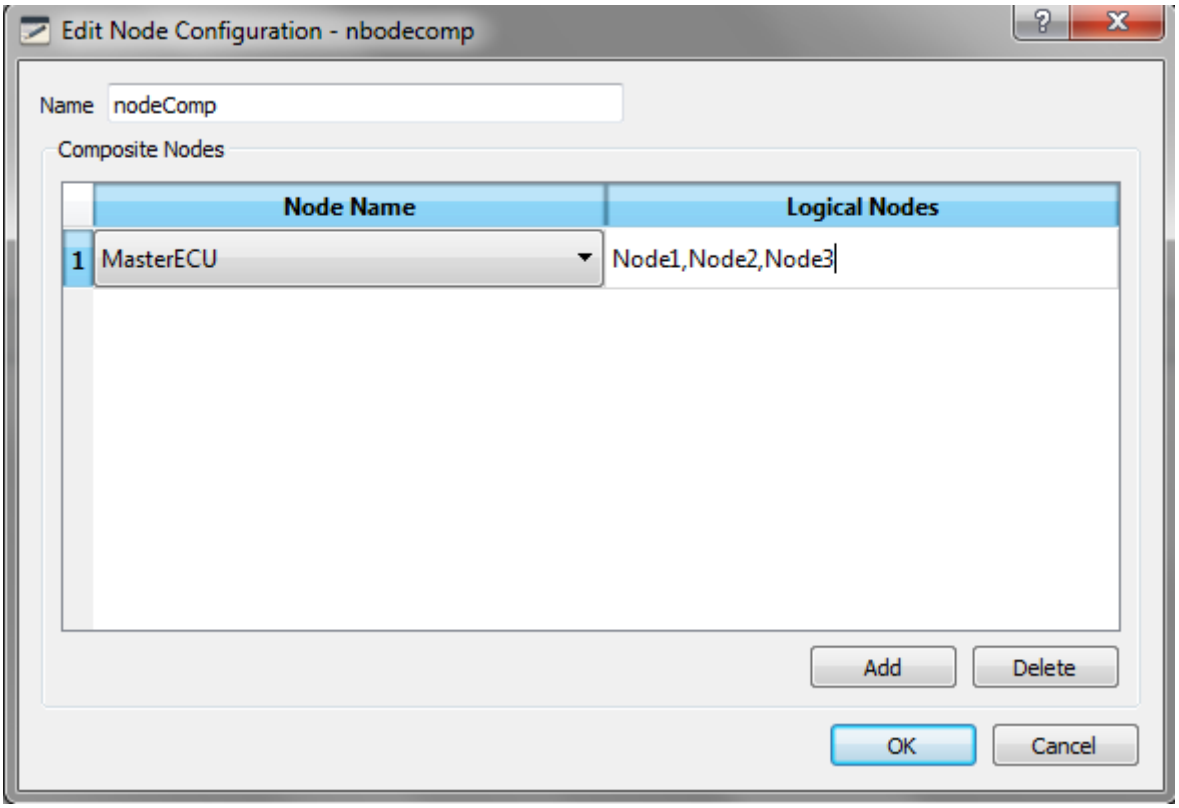
To create Node Configuration right click on the Node Composition element in the element view and click on popup menu 'New'.Create Node Configuration dialog is as shown below.



1. **General Properties:**
   - **Name:** Name of the Node Configuration should follow C identifier rules and should be unique.
2. **Adding Node Composition:**
   - To Add Node Composition, click on 'Add' button which adds a new row in Node list.
   - Node Name drop down will be populated with the list of Nodes available.
   - Select the Node from the Node Name drop down.
   - Specify the logical nodes in the Logical Nodes field. Multiple Logical Nodes can be specified separating with comma.
3. **Deleting Node Composition Item:**
   - Select the Node Composition Item in the list and click on 'Delete' button

Editing Node Compositions:

To edit existing Node Configuration right click on the Node Composition in the Element view and click on 'Edit'. 'Edit Node Configuration' dialog is displayed as shown below.



Deleting Node Composition:

To delete Node Configuration, right click on the Node Configuration in the Element view and click on the popup menu 'Delete'. A confirmation message will be displayed before deleting the Node Configuration.

To save the changes click on 'OK' button. Errors are displayed if validation fails.

The following validations are performed:

- Node Configuration name will be checked for its uniqueness
- Logical Nodes will be checked for its uniqueness

To discard the changes click on 'Cancel' button.

C Library Functions

Standard Library Functions

This chapter groups utility functions useful in a variety of programs. The corresponding declarations are in the header file `stdlib.h'.

abs : integer absolute value (magnitude)

Synopsis

```
#include <stdlib.h>
int abs(int i);
```

Description

abs returns the absolute value of i (also called the magnitude of i). That is, if i is negative, the result is the opposite of i, but if i is nonnegative the result is i.

The similar function labs uses and returns long rather than int values.

Returns

The result is a nonnegative integer.

atexit : request execution of functions at program exit

Synopsis

```
#include <stdlib.h>
int atexit(void (*function)(void);
```

Description

You can use atexit to enroll functions in a list of functions that will be called when your program terminates normally. The argument is a pointer to a user-defined function (which must not require arguments and must not return a result). The functions are kept in a LIFO stack; that is, the last function enrolled by atexit will be the first to execute when your program exits. There is no built-in limit to the number of functions you can enroll in this list; however, after every group of 32 functions is enrolled, atexit will call malloc to get space for the next part of the list. The initial list of 32 functions is statically allocated, so you can always count on at least that many slots available.

Returns

atexit returns 0 if it succeeds in enrolling your function, -1 if it fails (possible only if no space was available for malloc to extend the list of functions).

atof, atoff : string to double or float

Synopsis

```
#include <stdlib.h>
double atof(const char *s);
float atoff(const char *s);
```

Description

atof converts the initial portion of a string to a double. atoff converts the initial portion of a string to a float. The functions parse the character string s, locating a substring which can be converted to a floating point value. The substring must match the format: [+|-]digits[.][digits][(e|E)[+|-]digits]

The substring converted is the longest initial fragment of s that has the expected format, beginning with the first non-whitespace character. The substring is empty if str is empty, consists entirely of whitespace, or if the first non-whitespace character is something other than +, -, ., or a digit.

atof(s) is implemented as strtod(s, NULL). atoff(s) is implemented as strtodf(s, NULL).

Returns

atof returns the converted substring value, if any, as a double; or 0.0, if no conversion could be performed. If the correct value is out of the range of representable values, plus or minus HUGE_VAL is returned, and ERANGE is stored in errno. If the correct value would cause underflow, 0.0 is returned and ERANGE is stored in errno.

atoff obeys the same rules as atof, except that it returns a float.

atoi, atol : string to integer

Synopsis

```
#include <stdlib.h>
int atoi(const char *s);
long atol(const char *s);
```

Description

atoi converts the initial portion of a string to an int. atol converts the initial portion of a string to a long. atoi(s) is implemented as (int)strtol(s, NULL, 10). atol(s) is implemented as strtol(s, NULL, 10).

Returns

The functions return the converted value, if any. If no conversion was made, 0 is returned.

bsearch : binary search

Synopsis

```
#include <stdlib.h>
void *bsearch(const void *key, const void *base, size_t nmemb, size_t size,
 int (*compar)(const void *, const void *));
```

Description

bsearch searches an array beginning at base for any element that matches key, using binary search. nmemb is the element count of the array; size is the size of each element.

The array must be sorted in ascending order with respect to the comparison function compar (which you supply as the last argument of bsearch).

You must define the comparison function (*compar) to have two arguments; its result must be negative if the first argument is less than the second, zero if the two arguments match, and positive if the first argument is greater than the second (where "less than" and "greater than" refer to whatever arbitrary ordering is appropriate).

Returns

Returns a pointer to an element of array that matches key. If more than one matching element is available, the result may point to any of them.

calloc : allocate space for arrays

Synopsis

```
#include <stdlib.h>
void *calloc(size_t n, size_t s);
void *calloc_r(void *reent, size_t <n>, <size_t> s);
```

Description

Use calloc to request a block of memory sufficient to hold an array of n elements, each of which has size s.

The memory allocated by calloc comes out of the same memory pool used by malloc, but the memory block is initialized to all zero bytes. (To avoid the overhead of initializing the space, use malloc instead.)

The alternate functios _calloc_r is reentrant. The extra argument reent is a pointer to a reentrancy structure.

Returns

If successful, a pointer to the newly allocated space. If unsuccessful, NULL.

div : divide two integers

Synopsis

```
#include <stdlib.h>
div_t div(int n, int d);
```

Description

Divide returning quotient and remainder as two integers in a structure div_t.

Returns

The result is represented with the structure typedef struct { int quot; int rem; } div_t;

where the quot field represents the quotient, and rem the remainder. For nonzero d, if `r = div(n,d);' then n equals `r.rem + d*r.quot'.

To divide long rather than int values, use the similar function ldiv.

ecvt,ecvtf,fcvt,fcvtf : double or float to string

Synopsis

```
#include <stdlib.h>
char *ecvt(double val, int chars, int *decpt, int *sgn);
char *ecvtf(float val, int chars, int *decpt, int *sgn);
char *fcvt(double val, int decimals, int *decpt, int *sgn);
char *fcvtf(float val, int decimals, int *decpt, int *sgn);
```

Description

ecvt and fcvt produce (null-terminated) strings of digits representating the double number val. ecvtf and fcvtf produce the corresponding character representations of float numbers. (The stdlib functions ecvtbuf and fcvtbuf are reentrant versions of ecvt and fcvt.)

The only difference between ecvt and fcvt is the interpretation of the second argument (chars or decimals). For ecvt, the second argument chars specifies the total number of characters to write (which is also the number of significant digits in the formatted string, since these two functions write only digits). For fcvt, the second argument decimals specifies the number of characters to write after the decimal point; all digits for the integer part of val are always included.

Since ecvt and fcvt write only digits in the output string, they record the location of the decimal point in *decpt, and the sign of the number in *sgn. After formatting a number, *decpt contains the number of digits to the left of the decimal point. *sgn contains 0 if the number is positive, and 1 if it is negative.

Returns

All four functions return a pointer to the new string containing a character representation of val.

gvcvt, gcvtf : format double or float as string

Synopsis

```
#include <stdlib.h>
char *gcvt(double val, int precision, char *buf);
char *gcvtf(float val, int precision, char *buf);
```

Description

gcvt writes a fully formatted number as a null-terminated string in the buffer *buf. gdvtf produces corresponding character representations of float numbers.

gcvt uses the same rules as the printf format `%.precisiong' : only negative values are signed (with `-'), and either exponential or ordinary decimal-fraction format is chosen depending on the number of significant digits (specified by precision).

Returns

The result is a pointer to the formatted representation of val (the same as the argument buf).

ecvtbuf, fcvtbuf : double or float to string

Synopsis

```
#include <stdio.h>
char *ecvtbuf(double val, int chars, int *decpt, int *sgn, char *buf);
char *fcvtbuf(double val, int decimals, int *decpt, int *sgn, char *buf);
```

Description

ecvtbuf and fcvtbuf produce (null-terminated) strings of digits representating the double number val.

The only difference between ecvtbuf and fcvtbuf is the interpretation of the second argument (chars or decimals). For ecvtbuf, the second argument chars specifies the total number of characters to write (which is also the number of significant digits in the formatted string, since these two functions write only digits). For fcvtbuf, the second argument decimals specifies the number of characters to write after the decimal point; all digits for the integer part of val are always included.

Since ecvtbuf and fcvtbuf write only digits in the output string, they record the location of the decimal point in *decpt, and the sign of the number in *sgn. After formatting a number, *decpt contains the number of digits to the left of the decimal point. *sgn contains 0 if the number is positive, and 1 if it is negative. For both functions, you supply a pointer buf to an area of memory to hold the converted string.

Returns

Both functions return a pointer to buf, the string containing a character representation of val.

exit : end program execution

Synopsis

```
#include <stdlib.h>
void exit(int code);
```

Description

Use exit to return control from a program to the host operating environment. Use the argument code to pass an exit status to the operating environment: two particular values, EXIT_SUCCESS and EXIT_FAILURE, are defined in `stdlib.h' to indicate success or failure in a portable fashion.

exit does two kinds of cleanup before ending execution of your program. First, it calls all application-defined cleanup functions you have enrolled with atexit. Second, files and streams are cleaned up: any pending output is delivered to the host system, each open file or stream is closed, and files created by tmpfile are deleted.

Returns

exit does not return to its caller.

getenv : look up environment variable

Synopsis

```
#include <stdlib.h>
char *getenv(const char *name);
```

Description

getenv searches the list of environment variable names and values (using the global pointer `char **environ') for a variable whose name matches the string at name. If a variable name matches, getenv returns a pointer to the associated value.

Returns

A pointer to the (string) value of the environment variable, or NULL if there is no such environment variable.

labs : long integer absolute value

Synopsis

```
#include <stdlib.h>
long labs(long i);
```

Description

labs returns the absolute value of i (also called the magnitude of i). That is, if i is negative, the result is the opposite of i, but if i is nonnegative the result is i.

The similar function abs uses and returns int rather than long values.

Returns

The result is a nonnegative long integer.

ldiv : divide two long integers

Synopsis

```
#include <stdlib.h>
ldiv_t ldiv(long n, long d);
```

Description

Divide returning quotient and remainder as two long integers in a structure ldiv_t.

Returns

The result is represented with the structure

typedef struct { long quot; long rem; } ldiv_t;

where the quot field represents the quotient, and rem the remainder. For nonzero d, if `r = ldiv(n,d);' then n equals `r.rem + d*r.quot'.

To divide int rather than long values, use the similar function div.

malloc, realloc, free : manage memory

Synopsis

```
#include <stdlib.h>
void *malloc(size_t nbytes);
void *realloc(void *aptr, size_t nbytes);
void free(void *aptr);
void *_malloc_r(void *reent, size_t nbytes);
void *_realloc_r(void *reent, void *aptr, size_t nbytes);
void _free_r(void *reent, void *aptr);
```

Description

These functions manage a pool of system memory.

Use malloc to request allocation of an object with at least nbytes bytes of storage available. If the space is available, malloc returns a pointer to a newly allocated block as its result.

If you already have a block of storage allocated by malloc, but you no longer need all the space allocated to it, you can make it smaller by calling realloc with both the object pointer and the new desired size as arguments. realloc guarantees that the contents of the smaller object match the beginning of the original object.

Similarly, if you need more space for an object, use realloc to request the larger size; again, realloc guarantees that the beginning of the new, larger object matches the contents of the original object.

When you no longer need an object originally allocated by malloc or realloc (or the related function calloc), return it to the memory storage pool by calling free with the address of the object as the argument. You can also use realloc for this purpose by calling it with 0 as the nbytes argument.

The alternate functions _malloc_r, _realloc_r, and _free_r are reentrant versions. The extra argument reent is a pointer to a reentrancy structure.

Returns

malloc returns a pointer to the newly allocated space, if successful; otherwise it returns NULL. If your application needs to generate empty objects, you may use malloc(0) for this purpose.

realloc returns a pointer to the new block of memory, or NULL if a new block could not be allocated. NULL is also the result when you use `realloc(aptr,0)' (which has the same effect as `free(aptr)'). You should always check the result of realloc; successful reallocation is not guaranteed even when you request a smaller object.

free does not return a result.

mbtowc : minimal multibyte to wide char converter

Synopsis

```
#include <stdlib.h>
int mbtowc(wchar_t *pwc, const char *s, size_t n);
```

Description

This is a minimal ANSI-conforming implementation of mbtowc. The only "multi-byte character sequences" recognized are single bytes, and they are "converted" to themselves.

Each call to mbtowc copies one character from *s to *pwc, unless s is a null pointer.

In this implementation, the argument n is ignored.

Returns

This implementation of mbtowc returns 0 if s is NULL; it returns 1 otherwise (reporting the length of the character "sequence" used).

qsort : sort an array

Synopsis

```
#include <stdlib.h>
void qsort(void *base, size_t nmemb, size_t size, int (*compar)(const void
 *, const void *) );
```

Description

qsort sorts an array (beginning at base) of nmemb objects. size describes the size of each element of the array.

You must supply a pointer to a comparison function, using the argument shown as compar. (This permits sorting objects of unknown properties.) Define the comparison function to accept two arguments, each a pointer to an element of the array starting at base. The result of (*compar) must be negative if the first argument is less than the second, zero if the two arguments match, and positive if the first argument is greater than the second (where "less than" and "greater than" refer to whatever arbitrary ordering is appropriate).

The array is sorted in place; that is, when qsort returns, the array elements beginning at base have been reordered.

Returns

qsort does not return a result.

rand, srand : pseudo-random numbers

Synopsis

```
#include <stdlib.h>
int rand(void);
void srand(unsigned int seed);
int rand_r(unsigned int *seed);
```

Description

rand returns a different integer each time it is called; each integer is chosen by an algorithm designed to be unpredictable, so that you can use rand when you require a random number. The algorithm depends on a static variable called the "random seed"; starting with a given value of the random seed always produces the same sequence of numbers in successive calls to rand.

You can set the random seed using srand; it does nothing beyond storing its argument in the static variable used by rand. You can exploit this to make the pseudo-random sequence less predictable, if you wish, by using some other unpredictable value (often the least significant parts of a time-varying value) as the random seed before beginning a sequence of calls to rand; or, if you wish to ensure (for example, while debugging) that successive runs of your program use the same "random" numbers, you can use srand to set the same random seed at the outset.

Returns

rand returns the next pseudo-random integer in sequence; it is a number between 0 and RAND_MAX (inclusive).

srand does not return a result.

strtod, strtodf : string to double or float

Synopsis

```
#include <stdlib.h>
double strtod(const char *str, char **tail);
float strtodf(const char *str, char **tail);
double _strtod_r(void *reent, const char *str, char **tail);
```

Description

The function strtod parses the character string str, producing a substring which can be converted to a double value. The substring converted is the longest initial subsequence of str, beginning with the first non-whitespace character, that has the format: [+|-]digits[.][digits][(e|E)[+|-]digits]

The substring contains no characters if str is empty, consists entirely of whitespace, or if the first non-whitespace character is something other than +, -, ., or a digit. If the substring is empty, no conversion is done, and the value of str is stored in *tail. Otherwise, the substring is converted, and a pointer to the final string (which will contain at least the terminating null character of str) is stored in *tail. If you want no assignment to *tail, pass a null pointer as tail. strtodf is identical to strtod except for its return type.

This implementation returns the nearest machine number to the input decimal string. Ties are broken by using the IEEE round-even rule.

The alternate function _strtod_r is a reentrant version. The extra argument reent is a pointer to a reentrancy structure.

Returns

strtod returns the converted substring value, if any. If no conversion could be performed, 0 is returned. If the correct value is out of the range of representable values, plus or minus HUGE_VAL is returned, and ERANGE is stored in errno. If the correct value would cause underflow, 0 is returned and ERANGE is stored in errno.

strtol : string to long

Synopsis

```
#include <stdlib.h>
long strtol(const char *s, char **ptr,int base);
long _strtol_r(void *reent, const char *s, char **ptr,int base);
```

Description

The function strtol converts the string *s to a long. First, it breaks down the string into three parts: leading whitespace, which is ignored; a subject string consisting of characters resembling an integer in the radix specified by base; and a trailing portion consisting of zero or more unparseable characters, and always including the terminating null character. Then, it attempts to convert the subject string into a long and returns the result.

If the value of base is 0, the subject string is expected to look like a normal C integer constant: an optional sign, a possible `0x' indicating a hexadecimal base, and a number. If base is between 2 and 36, the expected form of the subject is a sequence of letters and digits representing an integer in the radix specified by base, with an optional plus or minus sign. The letters a--z (or, equivalently, A--Z) are used to signify values from 10 to 35; only letters whose ascribed values are less than base are permitted. If base is 16, a leading 0x is permitted.

The subject sequence is the longest initial sequence of the input string that has the expected form, starting with the first non-whitespace character. If the string is empty or consists entirely of whitespace, or if the first non-whitespace character is not a permissible letter or digit, the subject string is empty.

If the subject string is acceptable, and the value of base is zero, strtol attempts to determine the radix from the input string. A string with a leading 0x is treated as a hexadecimal value; a string with a leading 0 and no x is treated as octal; all other strings are treated as decimal. If base is between 2 and 36, it is used as the conversion radix, as described above. If the subject string begins with a minus sign, the value is negated. Finally, a pointer to the first character past the converted subject string is stored in ptr, if ptr is not NULL.

If the subject string is empty (or not in acceptable form), no conversion is performed and the value of s is stored in ptr (if ptr is not NULL).

The alternate function _strtol_r is a reentrant version. The extra argument reent is a pointer to a reentrancy structure.

Returns

strtol returns the converted value, if any. If no conversion was made, 0 is returned.

strtol returns LONG_MAX or LONG_MIN if the magnitude of the converted value is too large, and sets errno to ERANGE.

strtoul : string to unsigned long

Synopsis

```
#include <stdlib.h>
unsigned long strtoul(const char *s, char **ptr, int base);
unsigned long _strtoul_r(void *reent, const char *s, char **ptr, int base);
```

Description

The function strtoul converts the string *s to an unsigned long. First, it breaks down the string into three parts: leading whitespace, which is ignored; a subject string consisting of the digits meaningful in the radix specified by base (for example, 0 through 7 if the value of base is 8); and a trailing portion consisting of one or more unparseable characters, which always includes the terminating null character. Then, it attempts to convert the subject string into an unsigned long integer, and returns the result.

If the value of base is zero, the subject string is expected to look like a normal C integer constant (save that no optional sign is permitted): a possible 0x indicating hexadecimal radix, and a number. If base is between 2 and 36, the expected form of the subject is a sequence of digits (which may include letters, depending on the base) representing an integer in the radix specified by base. The letters a--z (or A--Z) are used as digits valued from 10 to 35. If base is 16, a leading 0x is permitted.

The subject sequence is the longest initial sequence of the input string that has the expected form, starting with the first non-whitespace character. If the string is empty or consists entirely of whitespace, or if the first non-whitespace character is not a permissible digit, the subject string is empty.

If the subject string is acceptable, and the value of base is zero, strtoul attempts to determine the radix from the input string. A string with a leading 0x is treated as a hexadecimal value; a string with a leading 0 and no x is treated as octal; all other strings are treated as decimal. If base is between 2 and 36, it is used as the conversion radix, as described above. Finally, a pointer to the first character past the converted subject string is stored in ptr, if ptr is not NULL.

If the subject string is empty (that is, if *s does not start with a substring in acceptable form), no conversion is performed and the value of s is stored in ptr (if ptr is not NULL).

The alternate function _strtoul_r is a reentrant version. The extra argument reent is a pointer to a reentrancy structure.

Returns

strtoul returns the converted value, if any. If no conversion was made, 0 is returned.

strtoul returns ULONG_MAX if the magnitude of the converted value is too large, and sets errno to ERANGE.

system : execute command string

Synopsis

```
#include <stdlib.h>
int system(char *s);
int _system_r(void *reent, char *s);
```

Description

Use system to pass a command string *s to /bin/sh on your system, and wait for it to finish executing.

Use `system(NULL)' to test whether your system has /bin/sh available.

The alternate function _system_r is a reentrant version. The extra argument reent is a pointer to a reentrancy structure.

Returns

system(NULL) returns a non-zero value if /bin/sh is available, and 0 if it is not.

With a command argument, the result of system is the exit status returned by /bin/sh.

wctomb : minimal wide char to multibyte converter

Synopsis

```
#include <stdlib.h>
int wctomb(char *s, wchar_t wchar);
```

Description

This is a minimal ANSI-conforming implementation of wctomb. The only "wide characters" recognized are single bytes, and they are "converted" to themselves.

Each call to wctomb copies the character wchar to *s, unless s is a null pointer.

Returns

This implementation of wctomb returns 0 if s is NULL; it returns 1 otherwise (reporting the length of the character "sequence" generated).

Character Type Macros and Functions

This chapter groups macros (which are also available as subroutines) to classify characters into several categories (alphabetic, numeric, control characters, whitespace, and so on), or to perform simple character mappings.

The header file `ctype.h' defines the macros.

isalnum : alphanumeric character predicate

Synopsis

```
#include <ctype.h>
int isalnum(int c);
```

Description

isalnum is a macro which classifies ASCII integer values by table lookup. It is a predicate returning non-zero for alphabetic or numeric ASCII characters, and 0 for other arguments. It is defined for all integer values.

You can use a compiled subroutine instead of the macro definition by undefining the macro using `#undef isalnum'.

Returns

isalnum returns non-zero if c is a letter (a--z or A--Z) or a digit (0--9).

isalpha : alphabetic character predicate

Synopsis

```
#include <ctype.h>
int isalpha(int c);
```

Description

isalpha is a macro which classifies ASCII integer values by table lookup. It is a predicate returning non-zero when c represents an alphabetic ASCII character, and 0 otherwise. It is defined only when isascii(c) is true or c is EOF.

You can use a compiled subroutine instead of the macro definition by undefining the macro using `#undef isalpha'.

Returns

isalpha returns non-zero if c is a letter (A--Z or a--z).

isascii : ASCII character predicate

Synopsis

```
#include <ctype.h>
int isascii(int c);
```

Description

isascii is a macro which returns non-zero when c is an ASCII character, and 0 otherwise. It is defined for all integer values.

You can use a compiled subroutine instead of the macro definition by undefining the macro using `#undef isascii'.

Returns

isascii returns non-zero if the low order byte of c is in the range 0 to 127 (0x00--0x7F).

iscntrl : control character predicate

Synopsis

```
#include <ctype.h>
int iscntrl(int c);
```

Description

iscntrl is a macro which classifies ASCII integer values by table lookup. It is a predicate returning non-zero for control characters, and 0 for other characters. It is defined only when isascii(c) is true or c is EOF.

You can use a compiled subroutine instead of the macro definition by undefining the macro using `#undef iscntrl'.

Returns

iscntrl returns non-zero if c is a delete character or ordinary control character (0x7F or 0x00--0x1F).

isdigit : decimal digit predicate

Synopsis

```
#include <ctype.h>
int isdigit(int c);
```

Description

isdigit is a macro which classifies ASCII integer values by table lookup. It is a predicate returning non-zero for decimal digits, and 0 for other characters. It is defined only when isascii(c) is true or c is EOF.

You can use a compiled subroutine instead of the macro definition by undefining the macro using `#undef isdigit'.

Returns

isdigit returns non-zero if c is a decimal digit (0--9).

islower : lower-case character predicate

Synopsis

```
#include <ctype.h>
int islower(int c);
```

Description

islower is a macro which classifies ASCII integer values by table lookup. It is a predicate returning non-zero for minuscules (lower-case alphabetic characters), and 0 for other characters. It is defined only when isascii(c) is true or c is EOF.

You can use a compiled subroutine instead of the macro definition by undefining the macro using `#undef islower'.

Returns

islower returns non-zero if c is a lower case letter (a--z).

isprint, isgraph : printable character predicate

Synopsis

```
#include <ctype.h>
int isprint(int c);
int isgraph(int c);
```

Description

isprint is a macro which classifies ASCII integer values by table lookup. It is a predicate returning non-zero for printable characters, and 0 for other character arguments. It is defined only when isascii(c) is true or c is EOF.

You can use a compiled subroutine instead of the macro definition by undefining either macro using `#undef isprint' or `#undef isgraph'.

Returns

isprint returns non-zero if c is a printing character, (0x20--0x7E). isgraph behaves identically to isprint, except that the space character (0x20) is excluded.

ispunct : punctuation character predicate

Synopsis

```
#include <ctype.h>
int ispunct(int c);
```

Description

ispunct is a macro which classifies ASCII integer values by table lookup. It is a predicate returning non-zero for printable punctuation characters, and 0 for other characters. It is defined only when isascii(c) is true or c is EOF.

You can use a compiled subroutine instead of the macro definition by undefining the macro using `#undef ispunct'.

Returns

ispunct returns non-zero if c is a printable punctuation character (isgraph(c) && !isalnum(c)). isspace : whitespace character predicate

isspace : whitespace character predicate

Synopsis

```
#include <ctype.h>
int isspace(int c);
```

Description

isspace is a macro which classifies ASCII integer values by table lookup. It is a predicate returning non-zero for whitespace characters, and 0 for other characters. It is defined only when isascii(c) is true or c is EOF.

You can use a compiled subroutine instead of the macro definition by undefining the macro using `#undef isspace'.

Returns

isspace returns non-zero if c is a space, tab, carriage return, new line, vertical tab, or formfeed (0x09--0x0D, 0x20).

isupper : uppercase character predicate

Synopsis

```
#include <ctype.h>
int isupper(int c);
```

Description

isupper is a macro which classifies ASCII integer values by table lookup. It is a predicate returning non-zero for upper-case letters (A--Z), and 0 for other characters. It is defined only when isascii(c) is true or c is EOF.

You can use a compiled subroutine instead of the macro definition by undefining the macro using `#undef isupper'.

Returns

isupper returns non-zero if c is a upper case letter (A-Z).

isxdigit : hexadecimal digit predicate

Synopsis

```
#include <ctype.h>
int isxdigit(int c);
```

Description

isxdigit is a macro which classifies ASCII integer values by table lookup. It is a predicate returning non-zero for hexadecimal digits, and 0 for other characters. It is defined only when isascii(c) is true or c is EOF.

You can use a compiled subroutine instead of the macro definition by undefining the macro using `#undef isxdigit'.

Returns

isxdigit returns non-zero if c is a hexadecimal digit (0--9, a--f, or A--F).

toascii : force integers to ASCII range

Synopsis

```
#include <ctype.h>
int toascii(int c);
```

Description

toascii is a macro which coerces integers to the ASCII range (0--127) by zeroing any higher-order bits.

You can use a compiled subroutine instead of the macro definition by undefining this macro using `#undef toascii'.

Returns

toascii returns integers between 0 and 127. tolower : translate characters to lower case

tolower : translate characters to lower case

Synopsis

```
#include <ctype.h>
int tolower(int c);
int _tolower(int c);
```

Description

tolower is a macro which converts upper-case characters to lower case, leaving all other characters unchanged. It is only defined when c is an integer in the range EOF to 255.

You can use a compiled subroutine instead of the macro definition by undefining this macro using `#undef tolower'.

_tolower performs the same conversion as tolower, but should only be used when c is known to be an uppercase character (A--Z).

Returns

tolower returns the lower-case equivalent of c when it is a character between A and Z, and c otherwise.

_tolower returns the lower-case equivalent of c when it is a character between A and Z. If c is not one of these characters, the behaviour of _tolower is undefined.

toupper : translate characters to upper case

Synopsis

```
#include <ctype.h>
int toupper(int c);
int _toupper(int c);
```

Description

toupper is a macro which converts lower-case characters to upper case, leaving all other characters unchanged. It is only defined when c is an integer in the range EOF to 255.

You can use a compiled subroutine instead of the macro definition by undefining this macro using `#undef toupper'.

_toupper performs the same conversion as toupper, but should only be used when c is known to be a lowercase character (a--z).

Returns

toupper returns the upper-case equivalent of c when it is a character between a and z, and c otherwise.

_toupper returns the upper-case equivalent of c when it is a character between a and z. If c is not one of these characters, the behaviour of _toupper is undefined.

I/O Functions

This chapter comprises functions to manage files or other input/output streams. Among these functions are subroutines to generate or scan strings according to specifications from a format string.

The underlying facilities for input and output depend on the host system, but these functions provide a uniform interface.

The corresponding declarations are in `stdio.h'.

The reentrant versions of these functions use macros

_stdin_r(reent) _stdout_r(reent) _stderr_r(reent)

instead of the globals stdin, stdout, and stderr. The argument <[reent]> is a pointer to a reentrancy structure.

clearerr : clear file or stream error indicator

Synopsis

```
#include <stdio.h>
void clearerr(FILE *fp);
```

Description

The stdio functions maintain an error indicator with each file pointer fp, to record whether any read or write errors have occurred on the associated file or stream. Similarly, it maintains an end-of-file indicator to record whether there is no more data in the file.

Use clearerr to reset both of these indicators.

See ferror and feof to query the two indicators.

Returns

clearerr does not return a result.

fclose : close a file

Synopsis

```
#include <stdio.h>
int fclose(FILE *fp);
```

Description

If the file or stream identified by fp is open, fclose closes it, after first ensuring that any pending data is written (by calling fflush(fp)).

Returns

fclose returns 0 if successful (including when fp is NULL or not an open file); otherwise, it returns EOF.

fdopen : turn open file into a stream

Synopsis

```
#include <stdio.h>
FILE *fdopen(int fd, const char *mode);
FILE *_fdopen_r(void *reent, int fd, const char *mode);
```

Description

fdopen produces a file descriptor of type FILE *, from a descriptor for an already-open file (returned, for example, by the system subroutine open rather than by fopen). The mode argument has the same meanings as in fopen.

Returns

File pointer or NULL, as for fopen.

feof : test for end of file

Synopsis

```
#include <stdio.h>
int feof(FILE *fp);
```

Description

feof tests whether or not the end of the file identified by fp has been reached.

Returns

feof returns 0 if the end of file has not yet been reached; if at end of file, the result is nonzero.

ferror : test whether read/write error has occurred

Synopsis

```
#include <stdio.h>
int ferror(FILE *fp);
```

Description

The stdio functions maintain an error indicator with each file pointer fp, to record whether any read or write errors have occurred on the associated file or stream. Use ferror to query this indicator.

See clearerr to reset the error indicator.

Returns

ferror returns 0 if no errors have occurred; it returns a nonzero value otherwise.

fflush : flush buffered file output

Synopsis

```
#include <stdio.h>
int fflush(FILE *fp);
```

Description

The stdio output functions can buffer output before delivering it to the host system, in order to minimize the overhead of system calls.

Use fflush to deliver any such pending output (for the file or stream identified by fp) to the host system.

If fp is NULL, fflush delivers pending output from all open files.

Returns

fflush returns 0 unless it encounters a write error; in that situation, it returns EOF.

fgetc : get a character from a file or stream

Synopsis

```
#include <stdio.h>
int fgetc(FILE *fp);
```

Description

Use fgetc to get the next single character from the file or stream identified by fp. As a side effect, fgetc advances the file's current position indicator.

For a macro version of this function, see getc.

Returns

The next character (read as an unsigned char, and cast to int), unless there is no more data, or the host system reports a read error; in either of these situations, fgetc returns EOF.

You can distinguish the two situations that cause an EOF result by using the ferror and feof functions.

fgetpos : record position in a stream or file

Synopsis

```
#include <stdio.h>
int fgetpos(FILE *fp, fpos_t *pos);
```

Description

Objects of type FILE can have a "position" that records how much of the file your program has already read. Many of the stdio functions depend on this position, and many change it as a side effect.

You can use fgetpos to report on the current position for a file identified by fp; fgetpos will write a value representing that position at *pos. Later, you can use this value with fsetpos to return the file to this position.

In the current implementation, fgetpos simply uses a character count to represent the file position; this is the same number that would be returned by ftell.

Returns

fgetpos returns 0 when successful. If fgetpos fails, the result is 1. Failure occurs on streams that do not support positioning; the global errno indicates this condition with the value ESPIPE.

fgets : get character string from a file or stream

Synopsis

```
#include <stdio.h>
char *fgets(char *buf, int n, FILE *fp);
```

Description

Reads at most n-1 characters from fp until a newline is found. The characters including to the newline are stored in buf. The buffer is terminated with a 0.

Returns

fgets returns the buffer passed to it, with the data filled in. If end of file occurs with some data already accumulated, the data is returned with no other indication. If no data are read, NULL is returned instead.

fiprintf : format output to file (integer only)

Synopsis

```
#include <stdio.h>
int fiprintf(FILE *fd, const char *format, ...);
```

Description

fiprintf is a restricted version of fprintf: it has the same arguments and behavior, save that it cannot perform any floating-point formatting--the f, g, G, e, and F type specifiers are not recognized.

Returns

fiprintf returns the number of bytes in the output string, save that the concluding NULL is not counted. fiprintf returns when the end of the format string is encountered. If an error occurs, fiprintf returns EOF.

fopen : open a file

Synopsis

```
#include <stdio.h>
FILE *fopen(const char *file, const char *mode);
FILE *_fopen_r(void *reent, const char *file, const char *mode);
```

Description

fopen initializes the data structures needed to read or write a file. Specify the file's name as the string at file, and the kind of access you need to the file with the string at mode.

The alternate function _fopen_r is a reentrant version. The extra argument reent is a pointer to a reentrancy structure.

Three fundamental kinds of access are available: read, write, and append. *mode must begin with one of the three characters `r', `w', or `a', to select one of these:

r	Open the file for reading; the operation will fail if the file does not exist, or if the host system does not permit you to read it.
w	Open the file for writing from the beginning of the file: effectively, this always creates a new file. If the file whose name you specified already existed, its old contents are discarded.
a	Open the file for appending data, that is writing from the end of file. When you open a file this way, all data always goes to the current end of file; you cannot change this using fseek.

Some host systems distinguish between "binary" and "text" files. Such systems may perform data transformations on data written to, or read from, files opened as "text". If your system is one of these, then you can append a `b' to any of the three modes above, to specify that you are opening the file as a binary file (the default is to open the file as a text file).

`rb', then, means "read binary"; `wb', "write binary"; and `ab', "append binary".

To make C programs more portable, the `b' is accepted on all systems, whether or not it makes a difference.

Finally, you might need to both read and write from the same file. You can also append a `+' to any of the three modes, to permit this. (If you want to append both `b' and `+', you can do it in either order: for example, "rb+" means the same thing as "r+b" when used as a mode string.)

Use "r+" (or "rb+") to permit reading and writing anywhere in an existing file, without discarding any data; "w +" (or "wb+") to create a new file (or begin by discarding all data from an old one) that permits reading and writing anywhere in it; and "a+" (or "ab+") to permit reading anywhere in an existing file, but writing only at the end.

Returns

fopen returns a file pointer which you can use for other file operations, unless the file you requested could not be opened; in that situation, the result is NULL. If the reason for failure was an invalid string at mode, errno is set to EINVAL.

fputc : write a character on a stream or file

Synopsis

```
#include <stdio.h>
int fputc(int ch, FILE *fp);
```

Description

fputc converts the argument ch from an int to an unsigned char, then writes it to the file or stream identified by fp.

If the file was opened with append mode (or if the stream cannot support positioning), then the new character goes at the end of the file or stream. Otherwise, the new character is written at the current value of the position indicator, and the position indicator oadvances by one.

For a macro version of this function, see putc.

Returns

If successful, fputc returns its argument ch. If an error intervenes, the result is EOF. You can use `ferror(fp)' to query for errors.

fputs : write a character string in a file or stream

Synopsis

```
#include <stdio.h>
int fputs(const char *s, FILE *fp);
```

Description

fputs writes the string at s (but without the trailing null) to the file or stream identified by fp.

Returns

If successful, the result is 0; otherwise, the result is EOF.

fread : read array elements from a file

Synopsis

```
#include <stdio.h>
size_t fread(void *buf, size_t size, size_t count, FILE *fp);
```

Description

fread attempts to copy, from the file or stream identified by fp, count elements (each of size size) into memory, starting at buf. fread may copy fewer elements than count if an error, or end of file, intervenes.

fread also advances the file position indicator (if any) for fp by the number of characters actually read.

Returns

The result of fread is the number of elements it succeeded in reading.

freopen : open a file using an existing file descriptor

Synopsis

```
#include <stdio.h>
FILE *freopen(const char *file, const char *mode, FILE *fp);
```

Description

Use this variant of fopen if you wish to specify a particular file descriptor fp (notably stdin, stdout, or stderr) for the file. If fp was associated with another file or stream, freopen closes that other file or stream (but ignores any errors while closing it). file and mode are used just as in fopen.

Returns

If successful, the result is the same as the argument fp. If the file cannot be opened as specified, the result is NULL.

fseek : set file position

Synopsis

```
#include <stdio.h>
int fseek(FILE *fp, long offset, int whence);
```

Description

Objects of type FILE can have a "position" that records how much of the file your program has already read. Many of the stdio functions depend on this position, and many change it as a side effect.

You can use fseek to set the position for the file identified by fp. The value of offset determines the new position, in one of three ways selected by the value of whence (defined as macros in `stdio.h'):

SEEK_SET : offset is the absolute file position (an offset from the beginning of the file) desired. offset must be positive.

SEEK_CUR : offset is relative to the current file position. offset can meaningfully be either positive or negative.

SEEK_END : offset is relative to the current end of file. offset can meaningfully be either positive (to increase the size of the file) or negative.

See ftell to determine the current file position.

Returns

fseek returns 0 when successful. If fseek fails, the result is EOF. The reason for failure is indicated in errno: either ESPIPE (the stream identified by fp doesn't support repositioning) or EINVAL (invalid file position).

fsetpos : restore position of a stream or file

Synopsis

```
#include <stdio.h>
int fsetpos(FILE *fp, const fpos_t *pos);
```

Description

Objects of type FILE can have a "position" that records how much of the file your program has already read. Many of the stdio functions depend on this position, and many change it as a side effect.

You can use fsetpos to return the file identified by fp to a previous position *pos (after first recording it with fgetpos).

See fseek for a similar facility.

Returns

fgetpos returns 0 when successful. If fgetpos fails, the result is 1. The reason for failure is indicated in errno: either ESPIPE (the stream identified by fp doesn't support repositioning) or EINVAL (invalid file position).

ftell : return position in a stream or file

Synopsis

```
#include <stdio.h>
long ftell(FILE *fp);
```

Description

Objects of type FILE can have a "position" that records how much of the file your program has already read. Many of the stdio functions depend on this position, and many change it as a side effect.

The result of ftell is the current position for a file identified by fp. If you record this result, you can later use it with fseek to return the file to this position.

In the current implementation, ftell simply uses a character count to represent the file position; this is the same number that would be recorded by fgetpos.

Returns

ftell returns the file position, if possible. If it cannot do this, it returns -1L. Failure occurs on streams that do not support positioning; the global errno indicates this condition with the value ESPIPE.

fwrite : write array elements

Synopsis

```
#include <stdio.h>
size_t fwrite(const void *buf, size_t size, size_t count, FILE *fp);
```

Description

fwrite attempts to copy, starting from the memory location buf, count elements (each of size size) into the file or stream identified by fp. fwrite may copy fewer elements than count if an error intervenes.

fwrite also advances the file position indicator (if any) for fp by the number of characters actually written.

Returns

If fwrite succeeds in writing all the elements you specify, the result is the same as the argument count. In any event, the result is the number of complete elements that fwrite copied to the file.

getc : read a character (macro)

Synopsis

```
#include <stdio.h>
int getc(FILE *fp);
```

Description

getc is a macro, defined in stdio.h. You can use getc to get the next single character from the file or stream identified by fp. As a side effect, getc advances the file's current position indicator.

For a subroutine version of this macro, see fgetc.

Returns

The next character (read as an unsigned char, and cast to int), unless there is no more data, or the host system reports a read error; in either of these situations, getc returns EOF.

You can distinguish the two situations that cause an EOF result by using the ferror and feof functions.

getchar : read a character (macro)

Synopsis

```
#include <stdio.h>
int getchar(void);
int _getchar_r(void *reent);
```

Description

getchar is a macro, defined in stdio.h. You can use getchar to get the next single character from the standard input stream. As a side effect, getchar advances the standard input's current position indicator.

The alternate function _getchar_r is a reentrant version. The extra argument reent is a pointer to a reentrancy structure.

Returns

The next character (read as an unsigned char, and cast to int), unless there is no more data, or the host system reports a read error; in either of these situations, getchar returns EOF.

You can distinguish the two situations that cause an EOF result by using `ferror(stdin)' and `feof(stdin)'.

gets : get character string (obsolete, use fgets instead)

Synopsis

```
#include <stdio.h>
char *gets(char *buf); char *_gets_r(void *reent, char *buf);
```

Description

Reads characters from standard input until a newline is found. The characters up to the newline are stored in buf. The newline is discarded, and the buffer is terminated with a 0.

This is a dangerous function, as it has no way of checking the amount of space available in buf. One of the attacks used by the Internet Worm of 1988 used this to overrun a buffer allocated on the stack of the finger daemon and overwrite the return address, causing the daemon to execute code downloaded into it over the connection.

The alternate function _gets_r is a reentrant version. The extra argument reent is a pointer to a reentrancy structure.

Returns

gets returns the buffer passed to it, with the data filled in. If end of file occurs with some data already accumulated, the data is returned with no other indication. If end of file occurs with no data in the buffer, NULL is returned.

Supporting OS subroutines required: close, fstat, isatty, lseek, read, sbrk, write.

iprintf : write formatted output (integer only)

Synopsis

```
#include <stdio.h>
int iprintf(const char *format, ...);
```

Description

iprintf is a restricted version of printf: it has the same arguments and behavior, save that it cannot perform any floating-point formatting: the f, g, G, e, and F type specifiers are not recognized.

Returns

iprintf returns the number of bytes in the output string, save that the concluding NULL is not counted. iprintf returns when the end of the format string is encountered. If an error occurs, iprintf returns EOF.

mktemp, mkstemp : generate unused file name

Synopsis

```
#include <stdio.h>
char *mktemp(char *path);
int mkstemp(char *path);
char *_mktemp_r(void *reent, char *path);
int *_mkstemp_r(void *reent, char *path);
```

Description

mktemp and mkstemp attempt to generate a file name that is not yet in use for any existing file. mkstemp creates the file and opens it for reading and writing; mktemp simply generates the file name.

You supply a simple pattern for the generated file name, as the string at path. The pattern should be a valid filename (including path information if you wish) ending with some number of `X' characters. The generated filename will match the leading part of the name you supply, with the trailing `X' characters replaced by some combination of digits and letters.

The alternate functions _mktemp_r and _mkstemp_r are reentrant versions. The extra argument reent is a pointer to a reentrancy structure.

Returns

mktemp returns the pointer path to the modified string representing an unused filename, unless it could not generate one, or the pattern you provided is not suitable for a filename; in that case, it returns NULL.

mkstemp returns a file descriptor to the newly created file, unless it could not generate an unused filename, or the pattern you provided is not suitable for a filename; in that case, it returns -1.

perror : print an error message on standard error

Synopsis

```
#include <stdio.h>
void perror(char *prefix);
void _perror_r(void *reent, char *prefix);
```

Description

Use perror to print (on standard error) an error message corresponding to the current value of the global variable errno. Unless you use NULL as the value of the argument prefix, the error message will begin with the string at prefix, followed by a colon and a space (:). The remainder of the error message is one of the strings described for strerror.

The alternate function _perror_r is a reentrant version. The extra argument reent is a pointer to a reentrancy structure.

Returns

perror returns no result.

printf, fprintf, sprintf : format output

Synopsis

```
#include <stdio.h>
int printf(const char *format [, arg, ...]);
int fprintf(FILE *fd, const char *format [, arg, ...]);
int sprintf(char *str, const char *format [, arg, ...]);
```

Description

printf accepts a series of arguments, applies to each a format specifier from *format, and writes the formatted data to stdout, terminated with a null character. The behavior of printf is undefined if there are not enough arguments for the format. printf returns when it reaches the end of the format string. If there are more arguments than the format requires, excess arguments are ignored.

fprintf and sprintf are identical to printf, other than the destination of the formatted output: fprintf sends the output to a specified file fd, while sprintf stores the output in the specified char array str. For sprintf, the behavior is also undefined if the output *str overlaps with one of the arguments. format is a pointer to a charater string containing two types of objects: ordinary characters (other than %), which are copied unchanged to the output, and conversion specifications, each of which is introduced by %. (To include % in the output, use %% in the format string.) A conversion specification has the following form:

%[flags][width][.prec][size][type]

The fields of the conversion specification have the following meanings:

- flags an optional sequence of characters which control output justification, numeric signs, decimal points, trailing zeroes, and octal and hex prefixes. The flag characters are minus (-), plus (+), space ( ), zero (0), and sharp (#). They can appear in any combination.
    - - The result of the conversion is left justified, and the right is padded with blanks. If you do not use this flag, the result is right justified, and padded on the left.

    - + The result of a signed conversion (as determined by type) will always begin with a plus or minus sign. (If you do not use this flag, positive values do not begin with a plus sign.)
    - " " (space) If the first character of a signed conversion specification is not a sign, or if a signed conversion results in no characters, the result will begin with a space. If the space ( ) flag and the plus (+) flag both appear, the space flag is ignored.
    - 0 If the type character is d, i, o, u, x, X, e, E, f, g, or G: leading zeroes, are used to pad the field width (following any indication of sign or base); no spaces are used for padding. If the zero (0) and minus (-) flags both appear, the zero (0) flag will be ignored. For d, i, o, u, x, and X conversions, if a precision prec is specified, the zero (0) flag is ignored. Note that 0 is interpreted as a flag, not as the beginning of a field width.
    - # The result is to be converted to an alternative form, according to the next character:
        - 0 increases precision to force the first digit of the result to be a zero.
        - x a non-zero result will have a 0x prefix.
        - X a non-zero result will have a 0X prefix.
        - e, E or f The result will always contain a decimal point even if no digits follow the point. (Normally, a decimal point appears only if a digit follows it.) Trailing zeroes are removed.
        - g or G same as e or E, but trailing zeroes are not removed.
        - all others undefined.
- width width is an optional minimum field width. You can either specify it directly as a decimal integer, or indirectly by using instead an asterisk (*), in which case an int argument is used as the field width. Negative field widths are not supported; if you attempt to specify a negative field width, it is interpreted as a minus (-) flag followed by a positive field width.
- prec an optional field; if present, it is introduced with `.' (a period). This field gives the maximum number of characters to print in a conversion; the minimum number of digits of an integer to print, for conversions with type d, i, o, u, x, and X; the maximum number of significant digits, for the g and G conversions; or the number of digits to print after the decimal point, for e, E, and f conversions. You can specify the precision either directly as a decimal integer or indirectly by using an asterisk (*), in which case an int argument is used as the precision. Supplying a negative precision is equivalent to omitting the precision. If only a period is specified the precision is zero. If a precision appears with any other conversion type than those listed here, the behavior is undefined.
- size h, l, and L are optional size characters which override the default way that printf interprets the data type of the corresponding argument. h forces the following d, i, o, u, x or X conversion type to apply to a short or unsigned short. h also forces a following n type to apply to a pointer to a short. Similarily, an l forces the following d, i, o, u, x or X conversion type to apply to a long or unsigned long. l also forces a following n type to apply to a pointer to a long. If an h or an l appears with another conversion specifier, the behavior is undefined. L forces a following e, E, f, g or G conversion type to apply to a long double argument. If L appears with any other conversion type, the behavior is undefined.
- type type specifies what kind of conversion printf performs. Here is a table of these:
    - % prints the percent character (%)
    - c prints arg as single character
    - s prints characters until precision is reached or a null terminator is encountered; takes a string pointer
    - d prints a signed decimal integer; takes an int (same as i)
    - i prints a signed decimal integer; takes an int (same as d)
    - o prints a signed octal integer; takes an int
    - u prints an unsigned decimal integer; takes an int
    - x prints an unsigned hexadecimal integer (using abcdef as digits beyond 9); takes an int
    - X prints an unsigned hexadecimal integer (using ABCDEF as digits beyond 9); takes an int
    - f prints a signed value of the form [-]9999.9999; takes a floating point number
    - e prints a signed value of the form [-]9.9999e[+|-]999; takes a floating point number
    - E prints the same way as e, but using E to introduce the exponent; takes a floating point number
    - g prints a signed value in either f or e form, based on given value and precision--trailing zeros and the decimal point are printed only if necessary; takes a floating point number
    - G prints the same way as g, but using E for the exponent if an exponent is needed; takes a floating point number
    - n stores (in the same object) a count of the characters written; takes a pointer to int

- p prints a pointer in an implementation-defined format. This implementation treats the pointer as an unsigned long (same as Lu).

Returns

sprintf returns the number of bytes in the output string, save that the concluding NULL is not counted. printf and fprintf return the number of characters transmitted. If an error occurs, printf and fprintf return EOF. No error returns occur for sprintf.

putc : write a character (macro)

Synopsis

```
#include <stdio.h>
int putc(int ch, FILE *fp);
```

Description

putc is a macro, defined in stdio.h. putc writes the argument ch to the file or stream identified by fp, after converting it from an int to an unsigned char.

If the file was opened with append mode (or if the stream cannot support positioning), then the new character goes at the end of the file or stream. Otherwise, the new character is written at the current value of the position indicator, and the position indicator advances by one.

For a subroutine version of this macro, see fputc.

Returns

If successful, putc returns its argument ch. If an error intervenes, the result is EOF. You can use `ferror(fp)' to query for errors.

putchar : write a character (macro)

Synopsis

```
#include <stdio.h>
int putchar(int ch);
int _putchar_r(void *reent, int ch);
```

Description

putchar is a macro, defined in stdio.h. putchar writes its argument to the standard output stream, after converting it from an int to an unsigned char.

The alternate function _putchar_r is a reentrant version. The extra argument reent is a pointer to a reentrancy structure.

Returns

If successful, putchar returns its argument ch. If an error intervenes, the result is EOF. You can use `ferror(stdin)' to query for errors.

puts : write a character string

Synopsis

```
#include <stdio.h>
int puts(const char *s);
int _puts_r(void *reent, const char *s);
```

Description

puts writes the string at s (followed by a newline, instead of the trailing null) to the standard output stream.

The alternate function _puts_r is a reentrant version. The extra argument reent is a pointer to a reentrancy structure.

Returns

If successful, the result is a nonnegative integer; otherwise, the result is EOF.

remove : delete a file's name

Synopsis

```
#include <stdio.h>
int remove(char *filename);
int _remove_r(void *reent, char *filename);
```

Description

Use remove to dissolve the association between a particular filename (the string at filename) and the file it represents. After calling remove with a particular filename, you will no longer be able to open the file by that name.

In this implementation, you may use remove on an open file without error; existing file descriptors for the file will continue to access the file's data until the program using them closes the file.

The alternate function _remove_r is a reentrant version. The extra argument reent is a pointer to a reentrancy structure.

Returns

remove returns 0 if it succeeds, -1 if it fails.

rename : rename a file

Synopsis

```
#include <stdio.h>
int rename(const char *old, const char *new);
int _rename_r(void *reent, const char *old, const char *new);
```

Description

Use rename to establish a new name (the string at new) for a file now known by the string at old. After a successful rename, the file is no longer accessible by the string at old.

If rename fails, the file named *old is unaffected. The conditions for failure depend on the host operating system.

The alternate function _rename_r is a reentrant version. The extra argument reent is a pointer to a reentrancy structure.

Returns

The result is either 0 (when successful) or -1 (when the file could not be renamed).

rewind : reinitialize a file or stream

Synopsis

```
#include <stdio.h>
void rewind(FILE *fp);
```

Description

rewind returns the file position indicator (if any) for the file or stream identified by fp to the beginning of the file. It also clears any error indicator and flushes any pending output.

Returns

rewind does not return a result.

scanf, fscanf, sscanf : scan and format input

Synopsis

```
#include <stdio.h>
int scanf(const char *format [, arg, ...]);
int fscanf(FILE *fd, const char *format [, arg, ...]);
int sscanf(const char *str, const char *format [, arg, ...]);
```

Description

scanf scans a series of input fields from standard input, one character at a time. Each field is interpreted according to a format specifier passed to scanf in the format string at *format. scanf stores the interpreted input from each field at the address passed to it as the corresponding argument following format. You must supply the same number of format specifiers and address arguments as there are input fields.

There must be sufficient address arguments for the given format specifiers; if not the results are unpredictable and likely disasterous. Excess address arguments are merely ignored.

scanf often produces unexpected results if the input diverges from an expected pattern. Since the combination of gets or fgets followed by sscanf is safe and easy, that is the preferred way to be certain that a program is synchronized with input at the end of a line.

fscanf and sscanf are identical to scanf, other than the source of input: fscanf reads from a file, and sscanf from a string.

The string at *format is a character sequence composed of zero or more directives. Directives are composed of one or more whitespace characters, non-whitespace characters, and format specifications.

Whitespace characters are blank ( ), tab (\t), or newline (\n). When scanf encounters a whitespace character in the format string it will read (but not store) all consecutive whitespace characters up to the next non-whitespace character in the input.

Non-whitespace characters are all other ASCII characters except the percent sign (%). When scanf encounters a non-whitespace character in the format string it will read, but not store a matching non-whitespace character.

Format specifications tell scanf to read and convert characters from the input field into specific types of values, and store then in the locations specified by the address arguments.

Trailing whitespace is left unread unless explicitly matched in the format string. The format specifiers must begin with a percent sign (%) and have the following form:

%[*][width][size]type

Each format specification begins with the percent character (%). The other fields are:

- * an optional marker; if present, it suppresses interpretation and assignment of this input field.
- width an optional maximum field width: a decimal integer, which controls the maximum number of characters that will be read before converting the current input field. If the input field has fewer than width characters, scanf reads all the characters in the field, and then proceeds with the next field and its format specification. If a whitespace or a non-convertable character occurs before width character are read, the characters up to that character are read, converted, and stored. Then scanf proceeds to the next format specification.
- size h, l, and L are optional size characters which override the default way that scanf interprets the data type of the corresponding argument. Modifier Type(s) h d, i, o, u, x convert input to short, store in short object h D, I, O, U, X no effect e, f, c, s, n, p l d, i, o, u, x convert input to long, store in long object l e, f, g convert input to double store in a double object l D, I, O, U, X no effect c, s, n, p L d, i, o, u, x convert to long double, store in long double L all others no effect
- type A character to specify what kind of conversion scanf performs. Here is a table of the conversion characters:
- % No conversion is done; the percent character (%) is stored.
- c Scans one character. Corresponding arg: (char *arg).
- s Reads a character string into the array supplied. Corresponding arg: (char arg[]).

- [pattern] Reads a non-empty character string into memory starting at arg. This area must be large enough to accept the sequence and a terminating null character which will be added automatically. (pattern is discussed in the paragraph following this table). Corresponding arg: (char *arg).
- d Reads a decimal integer into the corresponding arg: (int *arg).
- D Reads a decimal integer into the corresponding arg: (long *arg).
- o Reads an octal integer into the corresponding arg: (int *arg).
- O Reads an octal integer into the corresponding arg: (long *arg).
- u Reads an unsigned decimal integer into the corresponding arg: (unsigned int *arg).
- U Reads an unsigned decimal integer into the corresponding arg: (unsigned long *arg).
- x,X Read a hexadecimal integer into the corresponding arg: (int *arg).
- e, f, g Read a floating point number into the corresponding arg: (float *arg).
- E, F, G Read a floating point number into the corresponding arg: (double *arg).
- i Reads a decimal, octal or hexadecimal integer into the corresponding arg: (int *arg).
- I Reads a decimal, octal or hexadecimal integer into the corresponding arg: (long *arg).
- n Stores the number of characters read in the corresponding arg: (int *arg).
- p Stores a scanned pointer. ANSI C leaves the details to each implementation; this implementation treats %p exactly the same as %U. Corresponding arg: (void **arg).

A pattern of characters surrounded by square brackets can be used instead of the s type character. pattern is a set of characters which define a search set of possible characters making up the scanf input field. If the first character in the brackets is a caret (^), the search set is inverted to include all ASCII characters except those between the brackets. There is also a range facility which you can use as a shortcut. %[0-9] matches all decimal digits. The hyphen must not be the first or last character in the set. The character prior to the hyphen must be lexically less than the character after it. Here are some pattern examples:

- %[abcd] matches strings containing only a, b, c, and d.
- %[^abcd] matches strings containing any characters except a, b, c, or d
- %[A-DW-Z] matches strings containing A, B, C, D, W, X, Y, Z
- %[z-a] matches the characters z, -, and a

Floating point numbers (for field types e, f, g, E, F, G) must correspond to the following general form: [+/-] ddddd[.]ddd [E|e[+|-]ddd] where objects inclosed in square brackets are optional, and ddd represents decimal, octal, or hexadecimal digits.

Returns

scanf returns the number of input fields successfully scanned, converted and stored; the return value does not include scanned fields which were not stored.

If scanf attempts to read at end-of-file, the return value is EOF.

If no fields were stored, the return value is 0.

scanf might stop scanning a particular field before reaching the normal field end character, or may terminate entirely.

scanf stops scanning and storing the current field and moves to the next input field (if any) in any of the following situations:

- The assignment suppressing character (*) appears after the % in the format specification; the current input field is scanned but not stored.
- width characters have been read (width is a width specification, a positive decimal integer).
- The next character read cannot be converted under the the current format (for example, if a Z is read when the format is decimal).
- The next character in the input field does not appear in the search set (or does appear in the inverted search set).

When scanf stops scanning the current input field for one of these reasons, the next character is considered unread and used as the first character of the following input field, or the first character in a subsequent read operation on the input.

scanf will terminate under the following circumstances:

- The next character in the input field conflicts with a corresponding non-whitespace character in the format string.
- The next character in the input field is EOF.
- The format string has been exhausted.

When the format string contains a character sequence that is not part of a format specification, the same character sequence must appear in the input; scanf will scan but not store the matched characters. If a conflict occurs, the first conflicting character remains in the input as if it had never been read.

setbuf : specify full buffering for a file or stream

Synopsis

```
#include <stdio.h>
void setbuf(FILE *fp, char *buf);
```

Description

setbuf specifies that output to the file or stream identified by fp should be fully buffered. All output for this file will go to a buffer (of size BUFSIZ, specified in `stdio.h'). Output will be passed on to the host system only when the buffer is full, or when an input operation intervenes.

You may, if you wish, supply your own buffer by passing a pointer to it as the argument buf. It must have size BUFSIZ. You can also use NULL as the value of buf, to signal that the setbuf function is to allocate the buffer.

Warnings

You may only use setbuf before performing any file operation other than opening the file.

If you supply a non-null buf, you must ensure that the associated storage continues to be available until you close the stream identified by fp.

Returns

setbuf does not return a result.

setvbuf : specify file or stream buffering

Synopsis

```
#include <stdio.h>
int setvbuf(FILE *fp, char *buf, int mode, size_t size);
```

Description

Use setvbuf to specify what kind of buffering you want for the file or stream identified by fp, by using one of the following values (from stdio.h) as the mode argument:

_IONBF Do not use a buffer: send output directly to the host system for the file or stream identified by fp.

_IOFBF Use full output buffering: output will be passed on to the host system only when the buffer is full, or when an input operation intervenes.

_IOLBF Use line buffering: pass on output to the host system at every newline, as well as when the buffer is full, or when an input operation intervenes.

Use the size argument to specify how large a buffer you wish. You can supply the buffer itself, if you wish, by passing a pointer to a suitable area of memory as buf. Otherwise, you may pass NULL as the buf argument, and setvbuf will allocate the buffer.

Warnings

You may only use setvbuf before performing any file operation other than opening the file.

If you supply a non-null buf, you must ensure that the associated storage continues to be available until you close the stream identified by fp.

Returns

A 0 result indicates success, EOF failure (invalid mode or size can cause failure).

siprintf : write formatted output (integer only)

Synopsis

```
#include <stdio.h>
int siprintf(char *str, const char *format [, arg, ...]);
```

Description

siprintf is a restricted version of sprintf: it has the same arguments and behavior, save that it cannot perform any floating-point formatting: the f, g, G, e, and F type specifiers are not recognized.

Returns

siprintf returns the number of bytes in the output string, save that the concluding NULL is not counted. siprintf returns when the end of the format string is encountered.

tmpfile : create a temporary file

Synopsis

```
#include <stdio.h>
FILE *tmpfile(void);
FILE *_tmpfile_r(void *reent);
```

Description

Create a temporary file (a file which will be deleted automatically), using a name generated by tmpnam. The temporary file is opened with the mode "wb+", permitting you to read and write anywhere in it as a binary file (without any data transformations the host system may perform for text files).

The alternate function _tmpfile_r is a reentrant version. The argument reent is a pointer to a reentrancy structure.

Returns

tmpfile normally returns a pointer to the temporary file. If no temporary file could be created, the result is NULL, and errno records the reason for failure.

tmpnam, tempnam : name for a temporary file

Synopsis

```
#include <stdio.h>
char *tmpnam(char *s);
char *tempnam(char *dir, char *pfx);
char *_tmpnam_r(void *reent, char *s);
char *_tempnam_r(void *reent, char *dir, char *pfx);
```

Description

Use either of these functions to generate a name for a temporary file. The generated name is guaranteed to avoid collision with other files (for up to TMP_MAX calls of either function).

tmpnam generates file names with the value of P_tmpdir (defined in `stdio.h') as the leading directory component of the path.

You can use the tmpnam argument s to specify a suitable area of memory for the generated filename; otherwise, you can call tmpnam(NULL) to use an internal static buffer.

tempnam allows you more control over the generated filename: you can use the argument dir to specify the path to a directory for temporary files, and you can use the argument pfx to specify a prefix for the base filename.

If dir is NULL, tempnam will attempt to use the value of environment variable TMPDIR instead; if there is no such value, tempnam uses the value of P_tmpdir (defined in `stdio.h').

If you don't need any particular prefix to the basename of temporary files, you can pass NULL as the pfx argument to tempnam.

_tmpnam_r and _tempnam_r are reentrant versions of tmpnam and tempnam respectively. The extra argument reent is a pointer to a reentrancy structure.

Warnings

The generated filenames are suitable for temporary files, but do not in themselves make files temporary. Files with these names must still be explicitly removed when you no longer want them.

If you supply your own data area s for tmpnam, you must ensure that it has room for at least L_tmpnam elements of type char.

Returns

Both tmpnam and tempnam return a pointer to the newly generated filename.

vprintf, vfprintf, vsprintf : format argument list

Synopsis

```
#include <stdio.h>
#include <stdarg.h>
int vprintf(const char *fmt, va_list list);
int vfprintf(FILE *fp, const char *fmt, va_list list);
int vsprintf(char *str, const char *fmt, va_list list);
int _vprintf_r(void *reent, const char *fmt, va_list list);
int _vfprintf_r(void *reent, FILE *fp, const char *fmt, va_list list);
int _vsprintf_r(void *reent, char *str, const char *fmt, va_list list);
```

Description

vprintf, vfprintf, and vsprintf are (respectively) variants of printf, fprintf, and sprintf. They differ only in allowing their caller to pass the variable argument list as a va_list object (initialized by va_start) rather than directly accepting a variable number of arguments.

Returns

The return values are consistent with the corresponding functions: vsprintf returns the number of bytes in the output string, save that the concluding NULL is not counted. vprintf and vfprintf return the number of characters transmitted. If an error occurs, vprintf and vfprintf return EOF. No error returns occur for vsprintf.

String and Memory Functions

String and Memory Functions This chapter describes string-handling functions and functions for managing areas of memory. The corresponding declarations are in `string.h'.

bcmp : compare two memory areas

Synopsis

```
#include <string.h>
int bcmp(const char *s1, const char *s2, size_t n);
```

Description

This function compares not more than n characters of the object pointed to by s1 with the object pointed to by s2.

This function is identical to memcmp.

Returns

The function returns an integer greater than, equal to or less than zero according to whether the object pointed to by s1 is greater than, equal to or less than the object pointed to by s2.

bcopy : copy memory regions

Synopsis

```
#include <string.h>
void bcopy(const char *in, char *out, size_t n);
```

Description

This function copies n bytes from the memory region pointed to by in to the memory region pointed to by out.

This function is implemented in term of memmove.

bzero : initialize memory to zero

Synopsis

```
#include <string.h>
void bzero(char *b, size_t length);
```

Description

bzero initializes length bytes of memory, starting at address b, to zero.

Returns

bzero does not return a result.

index : search for character in string

Synopsis

```
#include <string.h>
char * index(const char *string, int c);
```

Description

This function finds the first occurence of c (converted to a char) in the string pointed to by string (including the terminating null character).

This function is identical to strchr.

Returns

Returns a pointer to the located character, or a null pointer if c does not occur in string.

memchr : find character in memory

Synopsis

```
#include <string.h>
void *memchr(const void *src, int c, size_t length);
```

Description

This function searches memory starting at *src for the character c. The search only ends with the first occurrence of c, or after length characters; in particular, NULL does not terminate the search.

Returns

If the character c is found within length characters of *src, a pointer to the character is returned. If c is not found, then NULL is returned.

memcmp : compare two memory areas

Synopsis

```
#include <string.h>
int memcmp(const void *s1, const void *s2, size_t n);
```

Description

This function compares not more than n characters of the object pointed to by s1 with the object pointed to by s2.

Returns

The function returns an integer greater than, equal to or less than zero according to whether the object pointed to by s1 is greater than, equal to or less than the object pointed to by s2.

memcpy : copy memory regions

Synopsis

```
#include <string.h>
void* memcpy(void *out, const void *in, size_t n);
```

Description

This function copies n bytes from the memory region pointed to by in to the memory region pointed to by out.

If the regions overlap, the behavior is undefined.

Returns

memcpy returns a pointer to the first byte of the out region.

memmove : move possibly overlapping memory

Synopsis

```
#include <string.h>
void *memmove(void *dst, const void *src, size_t length);
```

Description

This function moves length characters from the block of memory starting at *src to the memory starting at *dst. memmove reproduces the characters correctly at *dst even if the two areas overlap.

Returns

The function returns dst as passed.

memset : set an area of memory

Synopsis

```
#include <string.h>
void *memset(const void *dst, int c, size_t length);
```

Description

This function converts the argument c into an unsigned char and fills the first length characters of the array pointed to by dst to the value.

Returns

memset returns the value of m.

rindex : reverse search for character in string

Synopsis

```
#include <string.h>
char * rindex(const char *string, int c);
```

Description

This function finds the last occurence of c (converted to a char) in the string pointed to by string (including the terminating null character).

This function is identical to strrchr.

Returns

Returns a pointer to the located character, or a null pointer if c does not occur in string.

strcat : concatenate strings

Synopsis

```
#include <string.h>
char *strcat(char *dst, const char *src);
```

Description

strcat appends a copy of the string pointed to by src (including the terminating null character) to the end of the string pointed to by dst. The initial character of src overwrites the null character at the end of dst.

Returns

This function returns the initial value of dst

strchr : search for character in string

Synopsis

```
#include <string.h>
char * strchr(const char *string, int c);
```

Description

This function finds the first occurence of c (converted to a char) in the string pointed to by string (including the terminating null character).

Returns

Returns a pointer to the located character, or a null pointer if c does not occur in string.

strcmp : character string compare

Synopsis

```
#include <string.h>
int strcmp(const char *a, const char *b);
```

Description

strcmp compares the string at a to the string at b.

Returns

If *a sorts lexicographically after *b, strcmp returns a number greater than zero. If the two strings match, strcmp returns zero. If *a sorts lexicographically before *b, strcmp returns a number less than zero.

strcoll : locale specific character string compare

Synopsis

```
#include <string.h>
int strcoll(const char *stra, const char * strb);
```

Description

strcoll compares the string pointed to by stra to the string pointed to by strb, using an interpretation appropriate to the current LC_COLLATE state.

Returns

If the first string is greater than the second string, strcoll returns a number greater than zero. If the two strings are equivalent, strcoll returns zero. If the first string is less than the second string, strcoll returns a number less than zero.

strcpy : copy string

Synopsis

```
#include <string.h>
char *strcpy(char *dst, const char *src);
```

Description

strcpy copies the string pointed to by src (including the terminating null character) to the array pointed to by dst.

Returns

This function returns the initial value of dst.

strcspn : count chars not in string

Synopsis

```
size_t strcspn(const char *s1, const char *s2);
```

Description

This function computes the length of the initial part of the string pointed to by s1 which consists entirely of characters NOT from the string pointed to by s2 (excluding the terminating null character).

Returns

strcspn returns the length of the substring found.

strerror : convert error number to string

Synopsis

```
#include <string.h>
char *strerror(int errnum);
```

Description

strerror converts the error number errnum into a string. The value of errnum is usually a copy of errno. If errnum is not a known error number, the result points to an empty string.

This implementation of strerror prints out the following strings for each of the values defined in `errno.h':

E2BIG Arg list too long

EACCES Permission denied

EADV Advertise error

EAGAIN No more processes

EBADF Bad file number

EBADMSG Bad message

EBUSY Device or resource busy

ECHILD No children

ECOMM Communication error

EDEADLK Deadlock

EEXIST File exists

EDOM Math argument

EFAULT Bad address

EFBIG File too large

EIDRM Identifier removed

EINTR Interrupted system call

EINVAL Invalid argument

EIO I/O error

EISDIR Is a directory

ELIBACC Cannot access a needed shared library

ELIBBAD Accessing a corrupted shared library

ELIBEXEC Cannot exec a shared library directly

ELIBMAX Attempting to link in more shared libraries than system limit

ELIBSCN .lib section in a.out corrupted

EMFILE Too many open files

EMLINK Too many links

EMULTIHOP Multihop attempted

ENAMETOOLONG File or path name too long

ENFILE Too many open files in system

ENODEV No such device

ENOENT No such file or directory

ENOEXEC Exec format error

ENOLCK No lock

ENOLINK Virtual circuit is gone

ENOMEM Not enough space

ENOMSG No message of desired type

ENONET Machine is not on the network

ENOPKG No package

ENOSPC No space left on device

ENOSR No stream resources

ENOSTR Not a stream

ENOSYS Function not implemented

ENOTBLK Block device required

ENOTDIR Not a directory

ENOTEMPTY Directory not empty

ENOTTY Not a character device

ENXIO No such device or address

EPERM Not owner

EPIPE Broken pipe

EPROTO Protocol error

ERANGE Result too large

EREMOTE Resource is remote

EROFS Read-only file system

ESPIPE Illegal seek

ESRCH No such process

ESRMNT Srmount error

ETIME Stream ioctl timeout

ETXTBSY Text file busy

EXDEV Cross-device link

Returns

This function returns a pointer to a string. Your application must not modify that string.

strlen : character string length

Synopsis

```
#include <string.h>
size_t strlen(const char *str);
```

Description

The strlen function works out the length of the string starting at *str by counting chararacters until it reaches a NULL character.

Returns

strlen returns the character count.

strlwr : force string to lower case

Synopsis

```
#include <string.h>
char *strlwr(char *a);
```

Description

strlwr converts each characters in the string at a to lower case.

Returns

strlwr returns its argument, a.

strncat : concatenate strings

Synopsis

```
#include <string.h>
char *strncat(char *dst, const char *src, size_t length);
```

Description

strncat appends not more than length characters from the string pointed to by src (including the terminating null character) to the end of the string pointed to by dst. The initial character of src overwrites the null character at the end of dst. A terminating null character is always appended to the result

Warnings

Note that a null is always appended, so that if the copy is limited by the length argument, the number of characters appended to dst is n + 1.

Returns

This function returns the initial value of dst

strncmp : character string compare

Synopsis

```
#include <string.h>
int strncmp(const char *a, const char * b, size_t length);
```

Description

strncmp compares up to length characters from the string at a to the string at b.

Returns

If *a sorts lexicographically after *b, strncmp returns a number greater than zero. If the two strings are equivalent, strncmp returns zero. If *a sorts lexicographically before *b, strncmp returns a number less than zero.

strncpy : counted copy string

Synopsis

```
#include <string.h>
char *strncpy(char *dst, const char *src, size_t length);
```

Description

strncpy copies not more than length characters from the the string pointed to by src (including the terminating null character) to the array pointed to by dst. If the string pointed to by src is shorter than length characters, null characters are appended to the destination array until a total of length characters have been written.

Returns

This function returns the initial value of dst.

strpbrk : find chars in string

Synopsis

```
#include <string.h>
```

```
char *strpbrk(const char *s1, const char *s2);
```

Description

This function locates the first occurence in the string pointed to by s1 of any character in string pointed to by s2 (excluding the terminating null character).

Returns

strpbrk returns a pointer to the character found in s1, or a null pointer if no character from s2 occurs in s1.

strrchr : reverse search for character in string

Synopsis

```
#include <string.h>
char * strrchr(const char *string, int c);
```

Description

This function finds the last occurence of c (converted to a char) in the string pointed to by string (including the terminating null character).

Returns

Returns a pointer to the located character, or a null pointer if c does not occur in string.

strspn : find initial match

Synopsis

```
#include <string.h>
size_t strspn(const char *s1, const char *s2);
```

Description

This function computes the length of the initial segment of the string pointed to by s1 which consists entirely of characters from the string pointed to by s2 (excluding the terminating null character).

Returns

strspn returns the length of the segment found.

strstr : find string segment

Synopsis

```
#include <string.h>
char *strstr(const char *s1, const char *s2);
```

Description

Locates the first occurence in the string pointed to by s1 of the sequence of characters in the string pointed to by s2 (excluding the terminating null character).

Returns

Returns a pointer to the located string segment, or a null pointer if the string s2 is not found. If s2 points to a string with zero length, the s1 is returned.

strtok : get next token from a string

Synopsis

```
#include <string.h>
char *strtok(char *source, const char *delimiters)
char *strtok_r(char *source, const char *delimiters, char **lasts)
```

Description

The strtok function is used to isolate sequential tokens in a null-terminated string, *source. These tokens are delimited in the string by at least one of the characters in *delimiters. The first time that strtok is called, *source should be specified; subsequent calls, wishing to obtain further tokens from the same string, should pass a null pointer instead. The separator string, *delimiters, must be supplied each time, and may change between calls.

The strtok function returns a pointer to the beginning of each subsequent token in the string, after replacing the separator character itself with a NUL character. When no more tokens remain, a null pointer is returned.

The strtok_r function has the same behavior as strtok, except a pointer to placeholder *[lasts> must be supplied by the caller.

Returns

strtok returns a pointer to the next token, or NULL if no more tokens can be found.

strupr : force string to uppercase

Synopsis

```
#include <string.h>
char *strupr(char *a);
```

Description

strupr converts each characters in the string at a to upper case.

Returns

strupr returns its argument, a.

strxfrm : transform string

Synopsis

```
#include <string.h>
size_t strxfrm(char *s1, const char *s2, size_t n);
```

Description

This function transforms the string pointed to by s2 and places the resulting string into the array pointed to by s1. The transformation is such that if the strcmp function is applied to the two transformed strings, it returns a value greater than, equal to, or less than zero, correspoinding to the result of a strcoll function applied to the same two original strings.

No more than n characters are placed into the resulting array pointed to by s1, including the terminating null character. If n is zero, s1 may be a null pointer. If copying takes place between objects that overlap, the behavior is undefined.

With a C locale, this function just copies.

Returns

The strxfrm function returns the length of the transformed string (not including the terminating null character). If the value returned is n or more, the contents of the array pointed to by s1 are indeterminate.

Time Functions

This chapter groups functions used either for reporting on time (elapsed, current, or compute time) or to perform calculations based on time.

The header file 'time.h' defines three types. clock_t and time_t are both used for representations of time particularly suitable for arithmetic. (In this implementation, quantities of type clock_t have the highest resolution possible on your machine, and quantities of type time_t resolve to seconds.) size_t is also defined if necessary for quantities representing sizes. `time.h' also defines the structure tm for the traditional representation of Gregorian calendar time as a series of numbers, with the following fields:

tm_sec

Seconds.

tm_min

Minutes.

tm_hour

Hours.

tm_mday

Day.

tm_mon

Month.

tm_year

Year (since 1900).

tm_wday

Day of week: the number of days since Sunday.

tm_yday

Number of days elapsed since last January 1.

tm_isdst

Daylight Savings Time flag: positive means DST in effect, zero means DST not in effect, negative means no information about DST is available.

asctime : format time as string

Synopsis

```
#include <time.h>
char *asctime(const struct tm *clock);
char *asctime_r(const struct tm *clock, char *buf);
```

Description

Format the time value at clock into a string of the form Wed Jun 15 11:38:07 1988

The string is generated in a static buffer; each call to asctime overwrites the string generated by previous calls.

Returns

A pointer to the string containing a formatted timestamp.

clock : cumulative processor time

Synopsis

```
#include <time.h>
clock_t clock(void);
```

Description

Calculates the best available approximation of the cumulative amount of time used by your program since it started. To convert the result into seconds, divide by the macro CLOCKS_PER_SEC.

Returns

The amount of processor time used so far by your program, in units defined by the machine-dependent macro CLOCKS_PER_SEC. If no measurement is available, the result is -1.

ctime : convert time to local and format as string

Synopsis

```
#include <time.h>
char *ctime(time_t clock);
char *ctime_r(time_t clock, char *buf);
```

Description

Convert the time value at clock to local time (like localtime) and format it into a string of the form Wed Jun 15 11:38:07 1988 (like asctime).

Returns

A pointer to the string containing a formatted timestamp.

difftime : subtract two times

Synopsis

```
#include <time.h>
double difftime(time_t tim1, time_t tim2);
```

Description

Subtracts the two times in the arguments: `tim1 - tim2'.

Returns

The difference (in seconds) between tim2 and tim1, as a double.

gmtime : convert time to UTC traditional form

Synopsis

```
#include <time.h>
struct tm *gmtime(const time_t *clock);
struct tm *gmtime_r(const time_t *clock, struct tm *res);
```

Description

gmtime assumes the time at clock represents a local time. gmtime converts it to UTC (Universal Coordinated Time, also known in some countries as GMT, Greenwich Mean time), then converts the representation from the arithmetic representation to the traditional representation defined by struct tm.

gmtime constructs the traditional time representation in static storage; each call to gmtime or localtime will overwrite the information generated by previous calls to either function.

Returns

A pointer to the traditional time representation (struct tm).

localtime : convert time to local representation

Synopsis

```
#include <time.h>
struct tm *localtime(time_t *clock);
struct tm *localtime_r(time_t *clock, struct tm *res);
```

Description

localtime converts the time at clock into local time, then converts its representation from the arithmetic representation to the traditional representation defined by struct tm.

localtime constructs the traditional time representation in static storage; each call to gmtime or localtime will overwrite the information generated by previous calls to either function.

mktime is the inverse of localtime.

Returns

A pointer to the traditional time representation (struct tm).

mktime : convert time to arithmetic representation

Synopsis

```
#include <time.h>
time_t mktime(struct tm *timp);
```

Description

mktime assumes the time at timp is a local time, and converts its representation from the traditional representation defined by struct tm into a representation suitable for arithmetic.

localtime is the inverse of mktime.

Returns

If the contents of the structure at timp do not form a valid calendar time representation, the result is -1. Otherwise, the result is the time, converted to a time_t value.

strftime : flexible calendar time formatter

Synopsis

```
#include <time.h>
size_t strftime(char *s, size_t maxsize, const char *format, const struct tm
 *timp);
```

Description

strftime converts a struct tm representation of the time (at timp) into a string, starting at s and occupying no more than maxsize characters.

You control the format of the output using the string at format. *format can contain two kinds of specifications: text to be copied literally into the formatted string, and time conversion specifications. Time conversion specifications are two-character sequences beginning with `%' (use `%%' to include a percent sign in the output). Each defined conversion specification selects a field of calendar time data from *timp, and converts it to a string in one of the following ways:

- %a An abbreviation for the day of the week.
- %A The full name for the day of the week.
- %b An abbreviation for the month name.
- %B The full name of the month.

- %c A string representing the complete date and time, in the form Mon Apr 01 13:13:13 1992
- %d The day of the month, formatted with two digits.
- %H The hour (on a 24-hour clock), formatted with two digits.
- %I The hour (on a 12-hour clock), formatted with two digits.
- %j The count of days in the year, formatted with three digits (from `001' to `366').
- %m The month number, formatted with two digits.
- %M The minute, formatted with two digits.
- %p Either `AM' or `PM' as appropriate.
- %S The second, formatted with two digits.
- %U The week number, formatted with two digits (from `00' to `53'; week number 1 is taken as beginning with the first Sunday in a year). See also %W.
- %w A single digit representing the day of the week: Sunday is day 0.
- %W Another version of the week number: like `%U', but counting week 1 as beginning with the first Monday in a year.
- %x A string representing the complete date, in a format like Mon Apr 01 1992
- %X A string representing the full time of day (hours, minutes, and seconds), in a format like 13:13:13
- %y The last two digits of the year.
- %Y The full year, formatted with four digits to include the century.
- %Z Defined by ANSI C as eliciting the time zone if available; it is not available in this implementation (which accepts `%Z' but generates no output for it).
- %% A single character, `%'.

Returns

When the formatted time takes up no more than maxsize characters, the result is the length of the formatted string. Otherwise, if the formatting operation was abandoned due to lack of room, the result is 0, and the string starting at s corresponds to just those parts of *format that could be completely filled in within the maxsize limit.

time : get current calendar time (as single number)

Synopsis

```
#include <time.h>
time_t time(time_t *t);
```

Description

time looks up the best available representation of the current time and returns it, encoded as a time_t. It stores the same value at t unless the argument is NULL.

Returns

A -1 result means the current time is not available; otherwise the result represents the current time.

C Math Library Functions

acos, acosf : arc cosine

Synopsis

```
#include <math.h>
double acos(double x);
float acosf(float x);
```

Description

acos computes the inverse cosine (arc cosine) of the input value. Arguments to acos must be in the range -1 to 1. acosf is identical to acos, except that it performs its calculations on floats.

Returns

If x is not between -1 and 1, the returned value is NaN (not a number) the global variable errno is set to EDOM, and a DOMAIN error message is sent as standard error output.

You can modify error handling for these functions using matherr.

acosh, acoshf : inverse hyperbolic cosine

Synopsis

```
#include <math.h>
double acosh(double x);
float acoshf(float x);
```

Description

acosh calculates the inverse hyperbolic cosine of x. acosh is defined as x must be a number greater than or equal to 1. acoshf is identical, other than taking and returning floats.

Returns

acosh and acoshf return the calculated value. If x less than 1, the return value is NaN and errno is set to EDOM. You can change the error-handling behavior with the non-ANSI matherr function.

asin, asinf : arc sine

Synopsis

```
#include <math.h>
double asin(double x);
float asinf(float x);
```

Description

asin computes the inverse sine (arc sine) of the argument x. Arguments to asin must be in the range -1 to 1. asinf is identical to asin, other than taking and returning floats. You can modify error handling for these routines using matherr.

Returns

If x is not in the range -1 to 1, asin and asinf return NaN (not a number), set the global variable errno to EDOM, and issue a DOMAIN error message. You can change this error treatment using matherr.

asinh, asinhf : inverse hyperbolic sine

Synopsis

```
#include <math.h>
double asinh(double x);
float asinhf(float x);
```

Description

asinh calculates the inverse hyperbolic sine of x. asinh is defined as asinhf is identical, other than taking and returning floats.

Returns

asinh and asinhf return the calculated value.

atan, atanf : arc tangent

Synopsis

```
#include <math.h>
double atan(double x);
float atanf(float x);
```

Description

atan computes the inverse tangent (arc tangent) of the input value. atanf is identical to atan, save that it operates on floats.

Returns

atan and atanf return the calculated value

atan2, atan2f : arc tangent of y/x

Synopsis

```
#include <math.h>
double atan2(double y,double x);
float atan2f(float y,float x);
```

Description

atan2 computes the inverse tangent (arc tangent) of y/x. atan2 produces the correct result even for angles near (that is, when x is near 0). atan2f is identical to atan2, save that it takes and returns float.

Returns

atan2 and atan2f return a value in radians. If both x and y are 0.0, atan2 causes a DOMAIN error. You can modify error handling for these functions using matherr.

atanh, atanhf : inverse hyperbolic tangent

Synopsis

```
#include <math.h>
double atanh(double x);
float atanhf(float x);
```

Description

atanh calculates the inverse hyperbolic tangent of x. atanhf is identical, other than taking and returning float values.

Returns

atanh and atanhf return the calculated value. If is greater than 1, the global errno is set to EDOM and the result is a NaN. A DOMAIN error is reported. If is 1, the global errno is set to EDOM; and the result is infinity with the same sign as x. A SING error is reported. You can modify the error handling for these routines using matherr.

jN,jNf,yN,yNf : Bessel functions

Synopsis

```
#include <math.h>
double j0(double x);
float j0f(float x);
double j1(double x);
float j1f(float x);
```

```
double jn(int n, double x);
float jnf(int n, float x);
double y0(double x);
float y0f(float x);
double y1(double x);
float y1f(float x);
double yn(int n, double x);
float ynf(int n, float x);
```

Description

The Bessel functions are a family of functions that solve the differential equation These functions have many applications in engineering and physics. jn calculates the Bessel function of the first kind of order n. j0 and j1 are special cases for order 0 and order 1 respectively. Similarly, yn calculates the Bessel function of the second kind of order n, and y0 and y1 are special cases for order 0 and 1. jnf, j0f, j1f, ynf, y0f, and y1f perform the same calculations, but on float rather than double values.

Returns

The value of each Bessel function at x is returned.

cbrt, cbrtf : cube root

Synopsis

```
#include <math.h>
double cbrt(double x);
float  cbrtf(float x);
```

Description

cbrt computes the cube root of the argument.

Returns

The cube root is returned.

copysign, copysignf : sign of y, magnitude of x

Synopsis

```
#include <math.h>
double copysign (double x, double y);
float copysignf (float x, float y);
```

Description

copysign constructs a number with the magnitude (absolute value) of its first argument, x, and the sign of its second argument, y. copysignf does the same thing; the two functions differ only in the type of their arguments and result.

Returns

copysign returns a double with the magnitude of x and the sign of y. copysignf returns a float with the magnitude of x and the sign of y.

cosh, coshf : hyperbolic cosine

Synopsis

```
#include <math.h>
double cosh(double x);
float coshf(float x);
```

Description

cosh computes the hyperbolic cosine of the argument x. cosh(x) is defined as Angles are specified in radians. coshf is identical, save that it takes and returns float.

Returns

The computed value is returned. When the correct value would create an overflow, cosh returns the value HUGE_VAL with the appropriate sign, and the global value errno is set to ERANGE. You can modify error handling for these functions using the function matherr.

erf, erff, erfc, erfcf : error function

Synopsis

```
#include <math.h>
double erf(double x);
float erff(float x);
double erfc(double x);
float erfcf(float x);
```

Description

erf calculates an approximation to the "error function", which estimates the probability that an observation will fall within x standard deviations of the mean (assuming a normal distribution). erfc calculates the complementary probability; that is, erfc(x) is 1 - erf(x). erfc is computed directly, so that you can use it to avoid the loss of precision that would result from subtracting large probabilities (on large x) from 1. erff and erfcf differ from erf and erfc only in the argument and result types.

Returns

For positive arguments, erf and all its variants return a probability--a number between 0 and 1.

exp, expf : exponential

Synopsis

```
#include <math.h>
double exp(double x);
float expf(float x);
```

Description

exp and expf calculate the exponential of x, that is, is the base of the natural system of logarithms, approximately 2.71828). You can use the (non-ANSI) function matherr to specify error handling for these functions.

Returns

On success, exp and expf return the calculated value. If the result underflows, the returned value is 0. If the result overflows, the returned value is HUGE_VAL. In either case, errno is set to ERANGE.

expm1, expm1f : exponential minus 1

Synopsis

```
#include <math.h>
double expm1(double x);
float expm1f(float x);
```

Description

expm1 and expm1f calculate the exponential of x and subtract 1, that is, is the base of the natural system of logarithms, approximately 2.71828). The result is accurate even for small values of x, where using exp(x)-1 would lose many significant digits.

Returns

e raised to the power x, minus 1.

fabs, fabsf : absolute value (magnitude)

Synopsis

```
#include <math.h>
double fabs(double x);
float fabsf(float x);
```

Description

fabs and fabsf calculate the absolute value (magnitude) of the argument x, by direct manipulation of the bit representation of x.

Returns

The calculated value is returned. No errors are detected.

floor, floorf, ceil, ceilf : floor and ceiling

Synopsis

```
#include <math.h>
double floor(double x);
float floorf(float x);
double ceil(double x);
float ceilf(float x);
```

Description

floor and floorf find the nearest integer less than or equal to x. ceil and ceilf find the nearest integer greater than or equal to x.

Returns

floor and ceil return the integer result as a double. floorf and ceilf return the integer result as a float.

fmod, fmodf : floating-point remainder (modulo)

Synopsis

```
#include <math.h>
double fmod(double x, double y)
float fmodf(float x, float y)
```

Description

The fmod and fmodf functions compute the floating-point remainder of x/y (x modulo y).

Returns

The fmod function returns the value for the largest integer i such that, if y is nonzero, the result has the same sign as x and magnitude less than the magnitude of y. fmod(x,0) returns NaN, and sets errno to EDOM. You can modify error treatment for these functions using matherr.

frexp, frexpf : split floating-point number

Synopsis

```
#include <math.h>
double frexp(double val, int *exp);
float frexpf(float val, int *exp);
```

Description

All non zero, normal numbers can be described as m * 2**p. frexp represents the double val as a mantissa m and a power of two p. The resulting mantissa will always be greater than or equal to 0.5, and less than 1.0 (as long as val is nonzero). The power of two will be stored in *exp. frexpf is identical, other than taking and returning floats rather than doubles.

Returns

frexp returns the mantissa m. If val is 0, infinity, or Nan, frexp will set *exp to 0 and return val.

gamma, gammaf, lgamma, lgammaf, gamma_r, gammaf_r, lgamma_r, lgammaf_r

Synopsis

```
#include <math.h>
double gamma(double x);
float gammaf(float x);
double lgamma(double x);
float lgammaf(float x);
double gamma_r(double x, int *signgamp);
float gammaf_r(float x, int *signgamp);
double lgamma_r(double x, int *signgamp);
float lgammaf_r(float x, int *signgamp);
```

Description

gamma calculates the natural logarithm of the gamma function of x. The gamma function (exp(gamma(x))) is a generalization of factorial, and retains the property that Accordingly, the results of the gamma function itself grow very quickly. gamma is defined as to extend the useful range of results representable.

The sign of the result is returned in the global variable signgam, which is declared in math.h. gammaf performs the same calculation as gamma, but uses and returns float values. lgamma and lgammaf are alternate names for gamma and gammaf. The use of lgamma instead of gamma is a reminder that these functions compute the log of the gamma function, rather than the gamma function itself.

The functions gamma_r, gammaf_r, lgamma_r, and lgammaf_r are just like gamma, gammaf, lgamma, and lgammaf, respectively, but take an additional argument. This additional argument is a pointer to an integer. This additional argument is used to return the sign of the result, and the global variable signgam is not used. These functions may be used for reentrant calls (but they will still set the global variable errno if an error occurs).

Returns

Normally, the computed result is returned. When x is a nonpositive integer, gamma returns HUGE_VAL and errno is set to EDOM. If the result overflows, gamma returns HUGE_VAL and errno is set to ERANGE. You can modify this error treatment using matherr.

hypot, hypotf : distance from origin

Synopsis

```
#include <math.h>
double hypot(double x, double y);
float hypotf(float x, float y);
```

Description

hypot calculates the Euclidean distance between the origin (0,0) and a point represented by the Cartesian coordinates (x,y). hypotf differs only in the type of its arguments and result.

Returns

Normally, the distance value is returned. On overflow, hypot returns HUGE_VAL and sets errno to ERANGE. You can change the error treatment with matherr.

ilogb, ilogbf : get exponent of floating point number

Synopsis

```
#include <math.h>
int ilogb(double val);
int ilogbf(float val);
```

Description

All non zero, normal numbers can be described as m * 2**p. ilogb and ilogbf examine the argument val, and return p. The functions frexp and frexpf are similar to ilogb and ilogbf, but also return m.

Returns

ilogb and ilogbf return the power of two used to form the floating point argument. If val is 0, they return -INT_MAX (INT_MAX is defined in limits.h). If val is infinite, or NaN, they return INT_MAX.

infinity, infinityf : representation of infinity

Synopsis

```
#include <math.h>
double infinity(void);
float infinityf(void);
```

Description

infinity and infinityf return the special number IEEE infinity in double and single precision arithmetic respectivly.

isnan,isnanf,isinf,isinff,finite,finitef : test for exceptional numbers

Synopsis

```
#include <ieeefp.h>
int isnan(double arg);
int isinf(double arg);
int finite(double arg);
int isnanf(float arg);
int isinff(float arg);
int finitef(float arg);
```

Description

These functions provide information on the floating point argument supplied. There are five major number formats -

zero a number which contains all zero bits.

subnormal Is used to represent number with a zero exponent, but a non zero fraction.

normal A number with an exponent, and a fraction

infinity A number with an all 1's exponent and a zero fraction.

NAN A number with an all 1's exponent and a non zero fraction.

Returns

isnan returns 1 if the argument is a nan. isinf returns 1 if the argument is infinity. finite returns 1 if the argument is zero, subnormal or normal. The isnanf, isinff and finitef perform the same operations as their isnan, isinf and finite counterparts, but on single precision floating point numbers.

ldexp, ldexpf : load exponent

Synopsis

```
#include <math.h>
double ldexp(double val, int exp);
float ldexpf(float val, int exp);
```

Description

ldexp calculates the value ldexpf is identical, save that it takes and returns float rather than double values.

Returns

ldexp returns the calculated value. Underflow and overflow both set errno to ERANGE. On underflow, ldexp and ldexpf return 0.0. On overflow, ldexp returns plus or minus HUGE_VAL.

log, logf : natural logarithms

Synopsis

```
#include <math.h>
double log(double x);
float logf(float x);
```

Description

Return the natural logarithm of x, that is, its logarithm base e (where e is the base of the natural system of logarithms, 2.71828...). log and logf are identical save for the return and argument types. You can use the (non-ANSI) function matherr to specify error handling for these functions.

Returns

Normally, returns the calculated value. When x is zero, the returned value is -HUGE_VAL and errno is set to ERANGE. When x is negative, the returned value is -HUGE_VAL and errno is set to EDOM. You can control the error behavior via matherr.

log10, log10f : base 10 logarithms

Synopsis

```
#include <math.h>
double log10(double x);
float log10f(float x);
```

Description

log10 returns the base 10 logarithm of x. It is implemented as log(x) / log(10). log10f is identical, save that it takes and returns float values.

Returns

log10 and log10f return the calculated value. See the description of log for information on errors.

log1p, log1pf : log of 1 + x

Synopsis

```
#include <math.h>
double log1p(double x);
float log1pf(float x);
```

Description

log1p calculates the natural logarithm of 1+x. You can use log1p rather than `log(1+x)' for greater precision when x is very small. log1pf calculates the same thing, but accepts and returns float values rather than double.

Returns

log1p returns a double, the natural log of 1+x. log1pf returns a float, the natural log of 1+x.

matherr : modifiable math error handler

Synopsis

```
#include <math.h>
int matherr(struct exception *e);
```

Description

matherr is called whenever a math library function generates an error. You can replace matherr by your own subroutine to customize error treatment. The customized matherr must return 0 if it fails to resolve the error, and non-zero if the error is resolved.

When matherr returns a nonzero value, no error message is printed and the value of errno is not modified. You can accomplish either or both of these things in your own matherr using the information passed in the structure *e.

This is the exception structure (defined in `math.h'):

```
struct exception {
        int type;
        char *name;
        double arg1, arg2, retval;
        int err;
};
```

The members of the exception structure have the following meanings:

type The type of mathematical error that occured; macros encoding error types are also defined in `math.h'.

name a pointer to a null-terminated string holding the name of the math library function where the error occurred.

arg1, arg2 The arguments which caused the error.

retval The error return value (what the calling function will return).

err If set to be non-zero, this is the new value assigned to errno.

The error types defined in `math.h' represent possible mathematical errors as follows:

DOMAIN An argument was not in the domain of the function; e.g. log(-1.0).

SING The requested calculation would result in a singularity; e.g. pow(0.0,-2.0)

OVERFLOW A calculation would produce a result too large to represent; e.g. exp(1000.0).

UNDERFLOW A calculation would produce a result too small to represent; e.g. exp(-1000.0).

TLOSS Total loss of precision. The result would have no significant digits; e.g. sin(10e70).

PLOSS Partial loss of precision.

Returns

The library definition for matherr returns 0 in all cases. You can change the calling function's result from a customized matherr by modifying e->retval, which propagates backs to the caller.

If matherr returns 0 (indicating that it was not able to resolve the error) the caller sets errno to an appropriate value, and prints an error message.

modf, modff : split fractional and integer parts

Synopsis

```
#include <math.h>
double modf(double val, double *ipart);
float modff(float val, float *ipart);
```

Description

modf splits the double val apart into an integer part and a fractional part, returning the fractional part and storing the integer part in *ipart. No rounding whatsoever is done; the sum of the integer and fractional parts is guaranteed to be exactly equal to val. That is, if . realpart = modf(val, &intpart); then `realpart+intpart' is the same as val. modff is identical, save that it takes and returns float rather than double values.

Returns

The fractional part is returned. Each result has the same sign as the supplied argument val.

nan, nanf : representation of infinity

Synopsis

```
#include <math.h>
double nan(void);
float nanf(void);
```

Description

nan and nanf return an IEEE NaN (Not a Number) in double and single precision arithmetic respectivly.

nextafter, nextafterf : get next number

Synopsis

```
#include <math.h>
double nextafter(double val, double dir);
float nextafterf(float val, float dir);
```

Description

nextafter returns the double) precision floating point number closest to val in the direction toward dir. nextafterf performs the same operation in single precision. For example, nextafter(0.0,1.0) returns the smallest positive number which is representable in double precision.

Returns

Returns the next closest number to val in the direction toward dir.

pow, powf : x to the power y

Synopsis

```
#include <math.h>
double pow(double x, double y);
float pow(float x, float y);
```

Description

pow and powf calculate x raised to the exp1.0nt y.

Returns

On success, pow and powf return the value calculated.

When the argument values would produce overflow, pow returns HUGE_VAL and set errno to ERANGE. If the argument x passed to pow or powf is a negative noninteger, and y is also not an integer, then errno is set to EDOM. If x and y are both 0, then pow and powf return 1. You can modify error handling for these functions using matherr.

rint, rintf, remainder, remainderf : round and remainder

Synopsis

```
#include <math.h>
double rint(double x);
float rintf(float x);
double remainder(double x, double y);
float remainderf(float x, float y);
```

Description

rint and rintf returns their argument rounded to the nearest integer. remainder and remainderf find the remainder of x/y; this value is in the range -y/2 .. +y/2.

Returns

rint and remainder return the integer result as a double.

scalbn, scalbnf : scale by integer

Synopsis

```
#include <math.h>
double scalbn(double x, int y);
float scalbnf(float x, int y);
```

Description

scalbn and scalbnf scale x by n, returning x times 2 to the power n. The result is computed by manipulating the exponent, rather than by actually performing an exponentiation or multiplication.

Returns

x times 2 to the power n.

sqrt, sqrtf : positive square root

Synopsis

```
#include <math.h>
double sqrt(double x);
float  sqrtf(float x);
```

Description

sqrt computes the positive square root of the argument. You can modify error handling for this function with matherr.

Returns

On success, the square root is returned. If x is real and positive, then the result is positive. If x is real and negative, the global value errno is set to EDOM (domain error).

sin, sinf, cos, cosf : sine or cosine

Synopsis

```
#include <math.h>
double sin(double x);
float  sinf(float x);
double cos(double x);
float cosf(float x);
```

Description

sin and cos compute (respectively) the sine and cosine of the argument x. Angles are specified in radians. sinf and cosf are identical, save that they take and return float values.

Returns

The sine or cosine of x is returned.

sinh, sinhf : hyperbolic sine

Synopsis

```
#include <math.h>
double sinh(double x);
float  sinhf(float x);
```

Description

sinh computes the hyperbolic sine of the argument x. Angles are specified in radians. sinh(x) is defined as sinhf is identical, save that it takes and returns float values.

Returns

The hyperbolic sine of x is returned.

When the correct result is too large to be representable (an overflow), sinh returns HUGE_VAL with the appropriate sign, and sets the global value errno to ERANGE. You can modify error handling for these functions with matherr.

tan, tanf : tangent

Synopsis

```
#include <math.h>
double tan(double x);
float tanf(float x);
```

Description

tan computes the tangent of the argument x. Angles are specified in radians. tanf is identical, save that it takes and returns float values.

Returns

The tangent of x is returned.

tanh, tanhf : hyperbolic tangent

Synopsis

```
#include <math.h>
double tanh(double x);
float tanhf(float x);
```

Description

tanh computes the hyperbolic tangent of the argument x. Angles are specified in radians. tanh(x) is defined as

```
sinh(x)/cosh(x)
```

tanhf is identical, save that it takes and returns float values.

Returns

The hyperbolic tangent of x is returned.

Miscellaneous Macros and Functions

This chapter describes miscellaneous routines not covered elsewhere.

unctrl : translate characters to upper case

Synopsis

```
#include <unctrl.h>
char *unctrl(int c);
int unctrllen(int c);
```

Description

unctrl is a macro which returns the printable representation of c as a string. unctrllen is a macro which returns the length of the printable representation of c.

Returns

unctrl returns a string of the printable representation of c. unctrllen returns the length of the string which is the printable representation of c.

Variable Argument Lists

The printf family of functions is defined to accept a variable number of arguments, rather than a fixed argument list. You can define your own functions with a variable argument list, by using macro definitions from either `stdarg.h' (for compatibility with ANSI C) or from `varargs.h' (for compatibility with a popular convention prior to ANSI C).

ANSI-standard macros, `stdarg.h'

In ANSI C, a function has a variable number of arguments when its parameter list ends in an ellipsis (...). The parameter list must also include at least one explicitly named argument; that argument is used to initialize the variable list data structure.

ANSI C defines three macros (va_start, va_arg, and va_end) to operate on variable argument lists. `stdarg.h' also defines a special type to represent variable argument lists: this type is called va_list.

Initialize variable argument list

Synopsis

```
#include <stdarg.h>
void va_start(va_list ap, rightmost);
```

Description

Use va_start to initialize the variable argument list ap, so that va_arg can extract values from it. rightmost is the name of the last explicit argument in the parameter list (the argument immediately preceding the ellipsis `...' that flags variable arguments in an ANSI C function header). You can only use va_start in a function declared using this ellipsis notation (not, for example, in one of its subfunctions).

Returns

va_start does not return a result.

Extract a value from argument list

Synopsis

```
#include <stdarg.h>
type va_arg(va_list ap, type);
```

Description

va_arg returns the next unprocessed value from a variable argument list ap (which you must previously create with va_start). Specify the type for the value as the second parameter to the macro, type.

You may pass a va_list object ap to a subfunction, and use va_arg from the subfunction rather than from the function actually declared with an ellipsis in the header; however, in that case you may only use va_arg from the subfunction. ANSI C does not permit extracting successive values from a single variable-argument list from different levels of the calling stack.

There is no mechanism for testing whether there is actually a next argument available; you might instead pass an argument count (or some other data that implies an argument count) as one of the fixed arguments in your function call.

Returns

va_arg returns the next argument, an object of type type.

Abandon a variable argument list

Synopsis

```
#include <stdarg.h>
void va_end(va_list ap);
```

Description

Use va_end to declare that your program will not use the variable argument list ap any further.

Returns

va_end does not return a result.

Traditional macros, `varargs.h'

If your C compiler predates ANSI C, you may still be able to use variable argument lists using the macros from the `varargs.h' header file. These macros resemble their ANSI counterparts, but have important differences in usage. In particular, since traditional C has no declaration mechanism for variable argument lists, two additional macros are provided simply for the purpose of defining functions with variable argument lists.

As with `stdarg.h', the type va_list is used to hold a data structure representing a variable argument list.

Declare variable arguments

Synopsis

```
#include <varargs.h>
function(va_alist) va_dcl
```

Description

To use the `varargs.h' version of variable argument lists, you must declare your function with a call to the macro va_alist as its argument list, and use va_dcl as the declaration. Do not use a semicolon after va_dcl.

Returns

These macros cannot be used in a context where a return is syntactically possible.

Initialize variable argument list

Synopsis

```
#include <varargs.h>
va_list ap; va_start(ap);
```

Description

With the `varargs.h' macros, use va_start to initialize a data structure ap to permit manipulating a variable argument list. ap must have the type va_alist.

Returns

va_start does not return a result.

Extract a value from argument list

Synopsis

```
#include <varargs.h>
type va_arg(va_list ap, type);
```

Description

va_arg returns the next unprocessed value from a variable argument list ap (which you must previously create with va_start). Specify the type for the value as the second parameter to the macro, type.

Returns

va_arg returns the next argument, an object of type type.

Abandon a variable argument list

Synopsis

```
#include <varargs.h>
va_end(va_list ap);
```

Description

Use va_end to declare that your program will not use the variable argument list ap any further.

Returns

va_end does not return a result.

Copyright

C Library functions help is taken from GCC help content and it is from

The Cygnus C Support Library

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Hot Keys

Hot keys are available for most frequently used operations. Following are the hot keys implemented.

Hot key	Operation
CTRL + ALT + C	Clear Message Window
CTRL + ALT + I	Toggle between Activate/Deactivate message interpretation mode.
CTRL + ALT + O	Toggle between Append/Overwrite display mode.
CTRL + ALT + R	Reset Message Window column header positions to default.
CTRL + ALT + H	Toggle between Hex/Dec display format.
CTRL + ALT + S	Toggle between Start/Stop sending messages cyclically.
CTRL + ALT + L	Toggle between Enable/Disable logging of messages.

Frequently Asked Questions

Question: I can log CAN Bus messages, and it looks like I can transmit them, but the Tester does not see the messages I transmit.

Answer: Follow the steps below

1. Disconnect the BUSMASTER application.Then click "option -> controller mode" if active mode is not selected please select it.
2. If baud rate is >= 500 Kbps use 120 ohm terminating resistors between CANH and CANL at both end of cable between USB hardware and ECU (Tester).

Question: BUSMASTER is able to receive messages but when message is transmitted application gives error?

Answer: Follow the steps below

1. Measure the voltage between Pin 2 and 3 and Pin 7 an 3 of the SUB-D connector Pins of the PCAN-USB when system is idle.
2. If voltage is not around 2.5v then CAN Transceiver (Philips PCA82C251T) has got damaged.

Question: BUSMASTER throws up an error saying BUSMASTER_Interface.h missing while compling. Why?

Answer:

Rebuilding the solution will solve the problem. When rebuild is selected, the visual studio will compile BUSMASTER.idl file and will generate BUSMASTER_Interface.h and BUSMASTER_Interface.c files.

Question: Why Toolbar replay buttons are not active after changing the active window? Answer: This is the intended behavior of the toolbar replay button.

This is because of the following functionality :

1. Add more than one log file for replay in Replay Configuration window

2. Select interactive replay

3. Connect to the network. Multiple replay windows will be displayed corresponding to the number of log files added for reply. If 2 log files are added then 2 interactive replay windows will be displayed on connect.

4. The replay toolbar functionality works based on the active interactive window. So making it general will not work.

Hence the tool bar is disabled.

Question: After the Message Replay Window is closed, there is no way to have it back. Answer:

In interactive replay method, the functionality of close button is basically stopping the replay. Hence the window will be closed and immediately the replay will be stopped. To get back the replay window, just disconnect and connect to the network again. No restart of application is required. Make sure, Interactive Replay Window option is selected in the Replay configuration window.

Question:The files union.h are created each time BUSMASTER starts. Due to this, any previous manual changes in these files are lost.

Answer:

Unions.h file generated is intended to use with BUSMASTER only. So any manual modification will not be retained. If any additional changes or definitions are required then the same can be achieved by creating a new header file and referring it in the cpp file or modifying in the database file itself.

Question:In Message window, close window does not work

Answer:

This is the intended behavior. Message window will always be kept open. If the window has to be hidden then uncheck the View --> Message Window menu option

Question:Error launching BUSMASTER. When BUSMASTER is installed and launched, error message "The application cannot be started because the application config is not correct" is displayed

Answer:

Install .Net framework 3.5 or above and try again. BUSMASTER has dependency with .Net Framework.

Unused chapters

Message Logging

User can configure the name of the log file to which the messages will be logged by following the steps given below

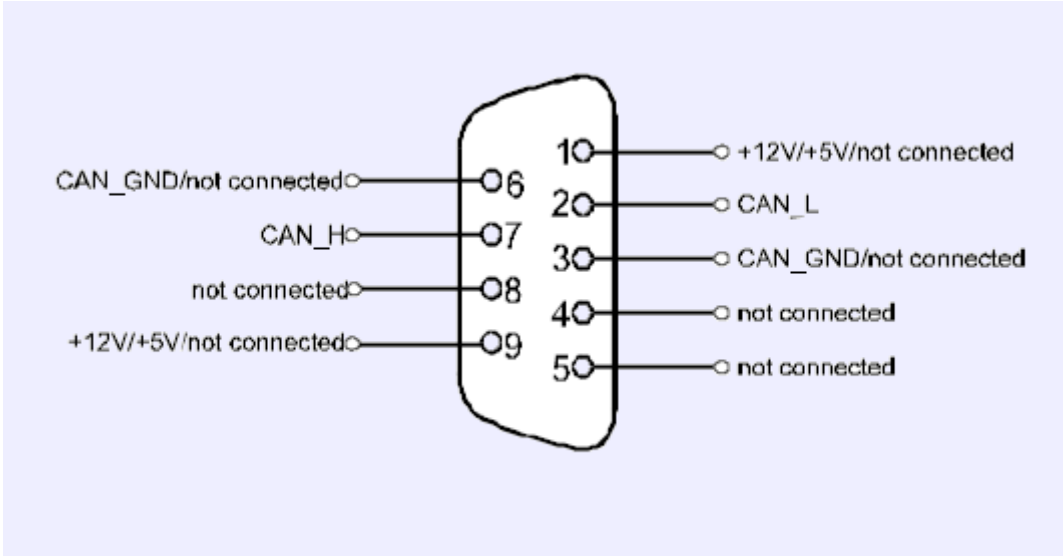
- Select **Configure** > **Log**
- Select log file name. You can also navigate to any folder to select the log file. If an existing file is selected it will be overwritten if Over Write Mode. Otherwise it will append the same log file for each new logging session. If a new file name is entered, you will be prompted to confirm the new file creation.
- Specify a message ID or select a message name, on reception of which, logging gets triggered

Connection Details

The connection to the CAN bus is via the 9 pole SUB-D-plug according to CiA Recommendation DS 102-1. Minimal configurations are the PINs 2 and 7 (CAN-L, CAN-H)

Pin Connection

1. User-defined +12V / +5V / not connected.
2. CAN-L
3. User-defined CAN-GND / not connected.
4. Not Connected.
5. Not Connected.
6. User-defined CAN-GND / not connected.
7. CAN-H
8. Not Connected.
9. User-defined +12V / +5V / not connected.



Additional Installation

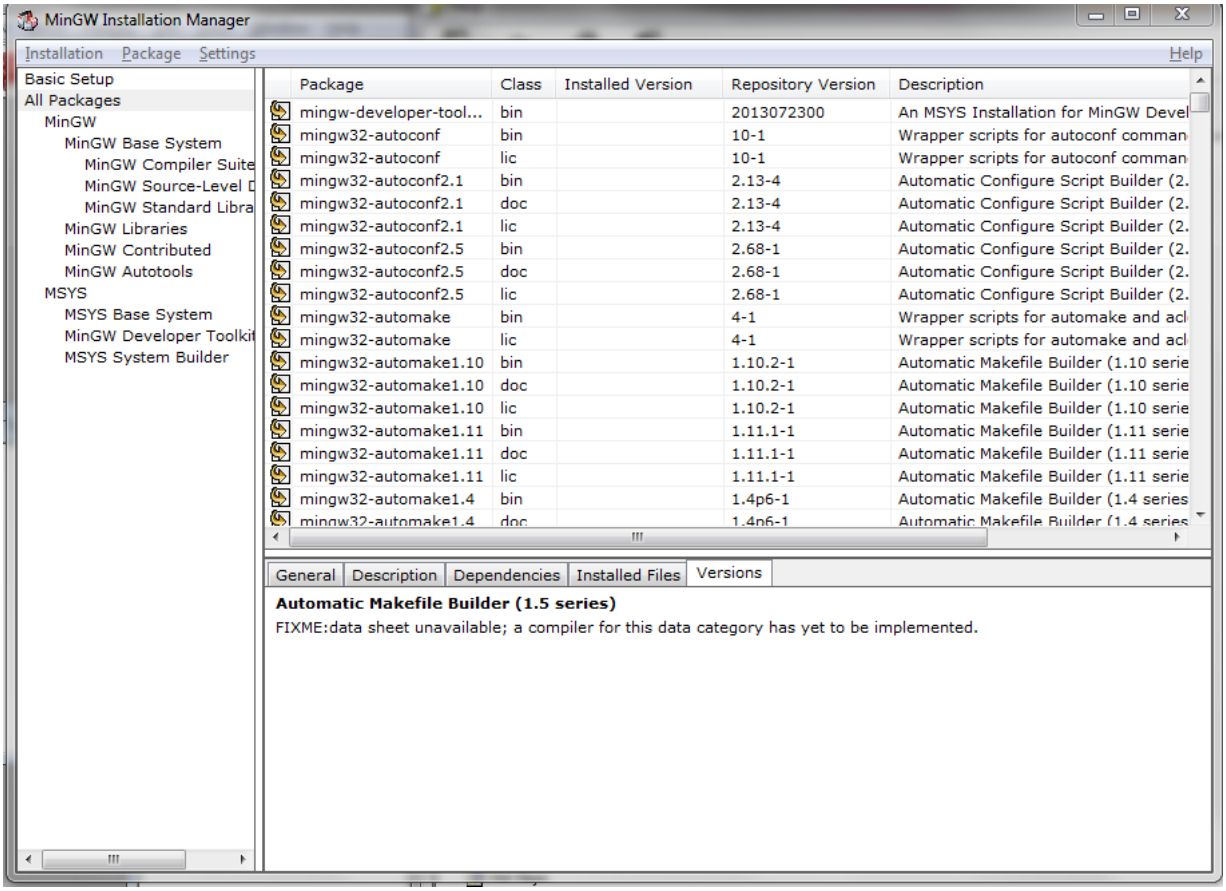
In BUSMASTER MinGw gcc compiler is used in Node Simulation to build and generate .dll files from user created .cpp file. Therefore any of the below two MinGw must be installed.

MinGW Installation using GCC Installer

MinGW Installation

The following steps should be followed to install MinGW and use it to successfully compile CPP files in Node Simulation using BUSMASTER.

- Download latest mingw executable from the following link *http://sourceforge.net/projects/mingw/files/Installer/mingw-get-inst/* and then use it to download the actual MinGW and copy the MinGW folder to C: drive
- During MinGW installation, please choose the packages as shown in the screen below as it is not selected by default:


MinGW Installation Manager
Installation Package Settings
Help
Basic Setup
All Packages
MinGW
MinGW Base System
MinGW Compiler Suite
MinGW Source-Level D
MinGW Standard Libra
MinGW Libraries
MinGW Contributed
MinGW Autotools
MSYS
MSYS Base System
MinGW Developer Toolkit
MSYS System Builder
Package Class Installed Version Repository Version Description
mingw-developer-tool... bin 2013072300 An MSYS Installation for MinGW Devel
mingw32-autoconf bin 10-1 Wrapper scripts for autoconf comman
mingw32-autoconf lic 10-1 Wrapper scripts for autoconf comman
mingw32-autoconf2.1 bin 2.13-4 Automatic Configure Script Builder (2.
mingw32-autoconf2.1 doc 2.13-4 Automatic Configure Script Builder (2.
mingw32-autoconf2.1 lic 2.13-4 Automatic Configure Script Builder (2.
mingw32-autoconf2.5 bin 2.68-1 Automatic Configure Script Builder (2.
mingw32-autoconf2.5 doc 2.68-1 Automatic Configure Script Builder (2.
mingw32-autoconf2.5 lic 2.68-1 Automatic Configure Script Builder (2.
mingw32-automake bin 4-1 Wrapper scripts for automake and acl
mingw32-automake lic 4-1 Wrapper scripts for automake and acl
mingw32-automake1.10 bin 1.10.2-1 Automatic Makefile Builder (1.10 serie
mingw32-automake1.10 doc 1.10.2-1 Automatic Makefile Builder (1.10 serie
mingw32-automake1.10 lic 1.10.2-1 Automatic Makefile Builder (1.10 serie
mingw32-automake1.11 bin 1.11.1-1 Automatic Makefile Builder (1.11 serie
mingw32-automake1.11 doc 1.11.1-1 Automatic Makefile Builder (1.11 serie
mingw32-automake1.11 lic 1.11.1-1 Automatic Makefile Builder (1.11 serie
mingw32-automake1.4 bin 1.4p6-1 Automatic Makefile Builder (1.4 series
General Description Dependencies Installed Files Versions
Automatic Makefile Builder (1.5 series)
FIXME:data sheet unavailable; a compiler for this data category has yet to be implemented.

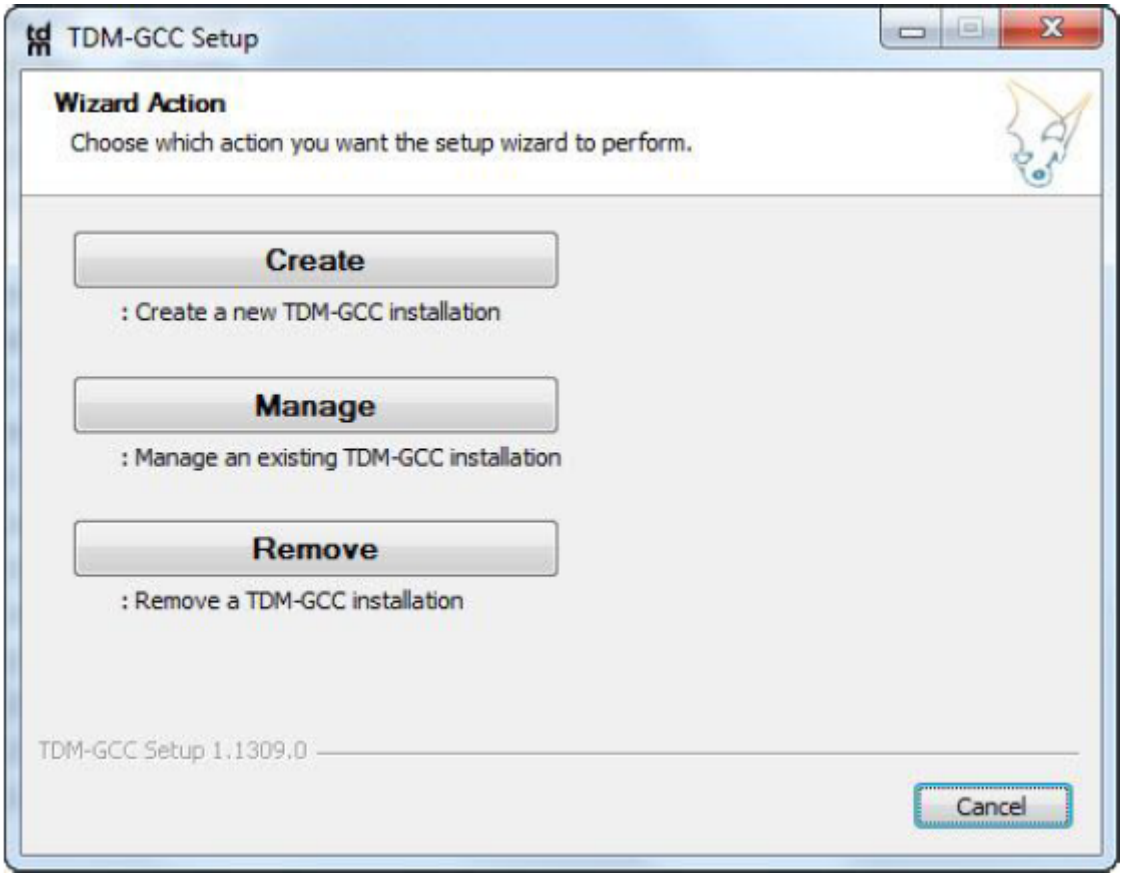
- Set the environment variable ‘path’ as ‘C:\MinGW\bin’.

MinGW Installation using TDM-GCC Installer

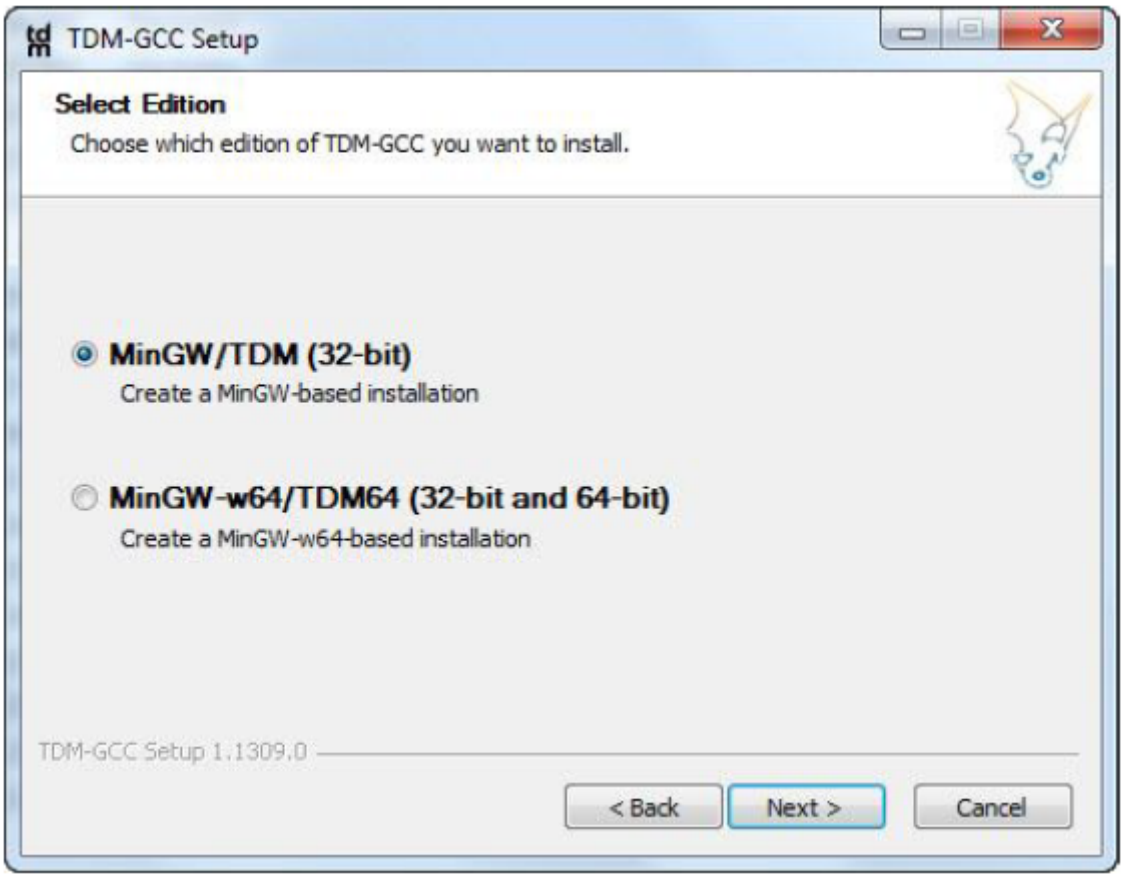
MinGW Installation

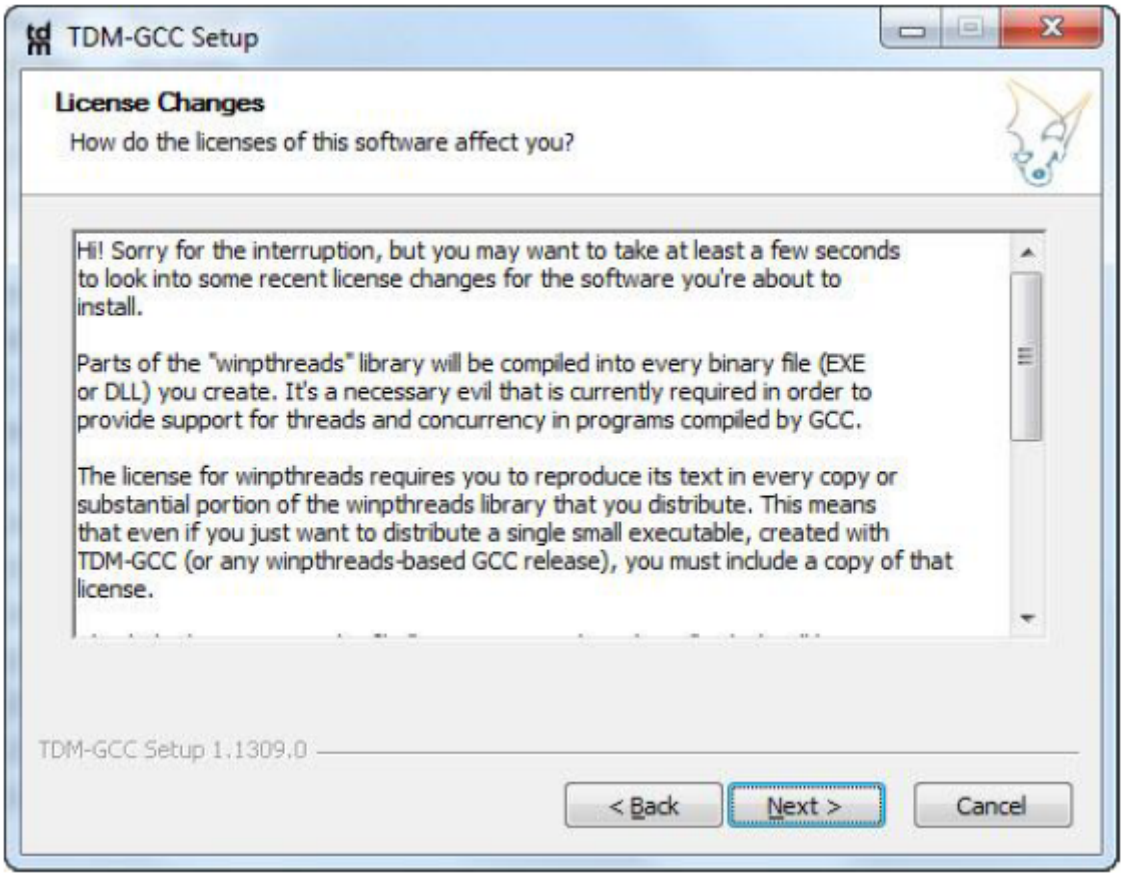
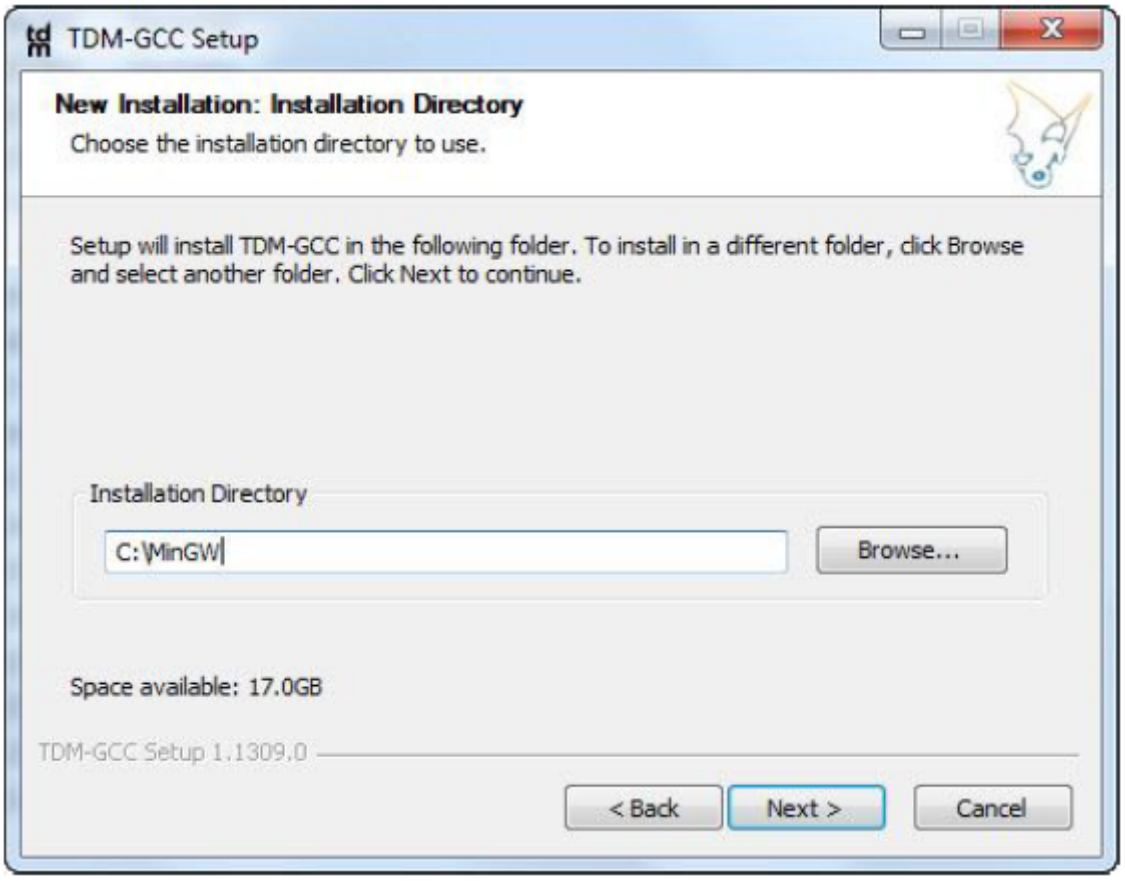
The following steps should be followed to Download and install MinGW using TDM-GCC Installer.

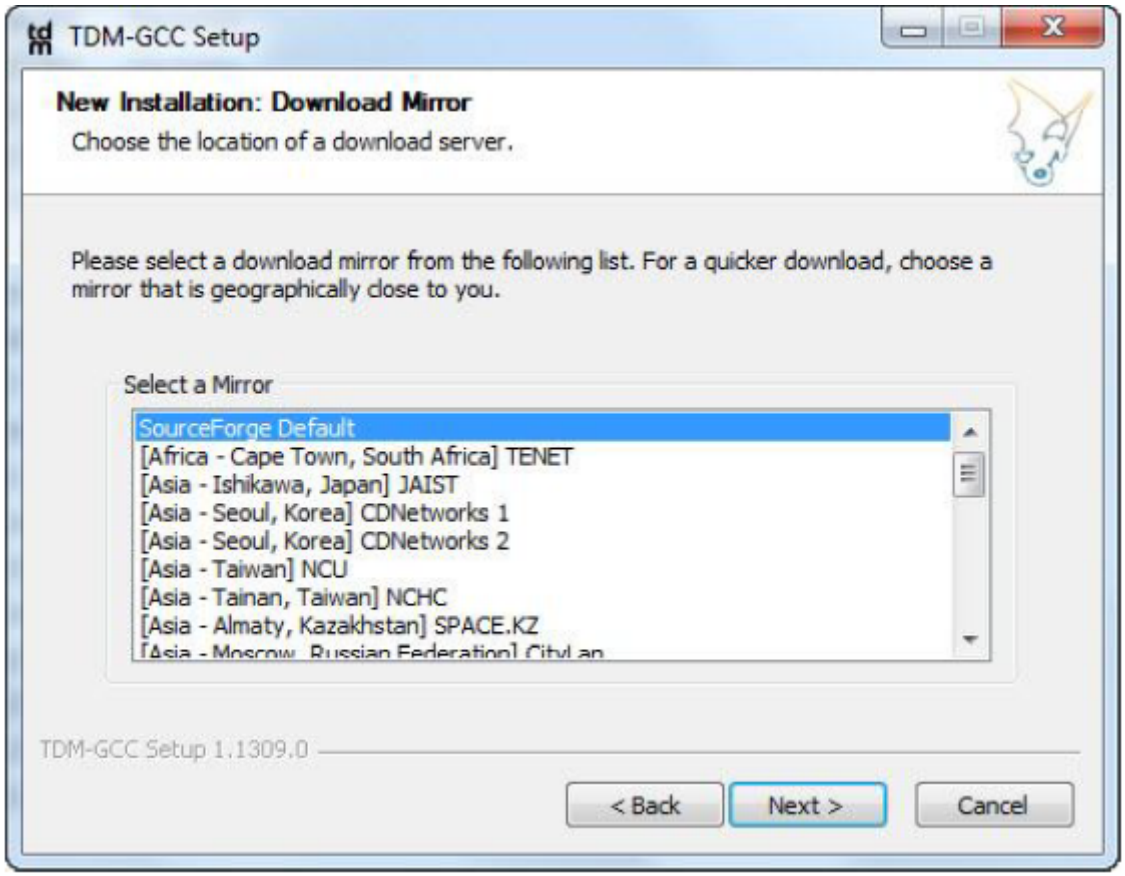
- Download the TDM-GCC from the following link *http://sourceforge.net/projects/tdm-gcc/files/TDM-GCC%20Installer/tdm-gccwebdl. exe/download*
- Run the installer. Following image will show the first screen of the installer.
-



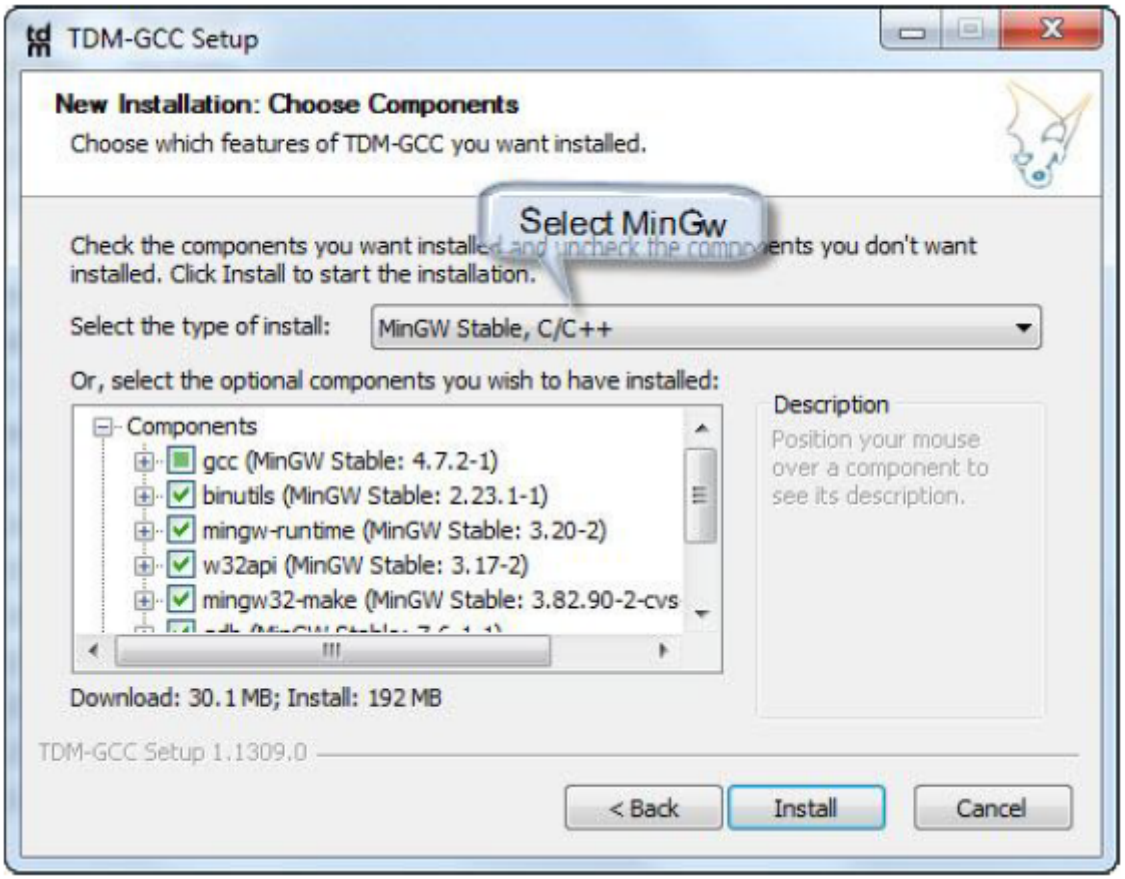
- Click on the create button, if you are installing the first time this will go to the following screen.
-



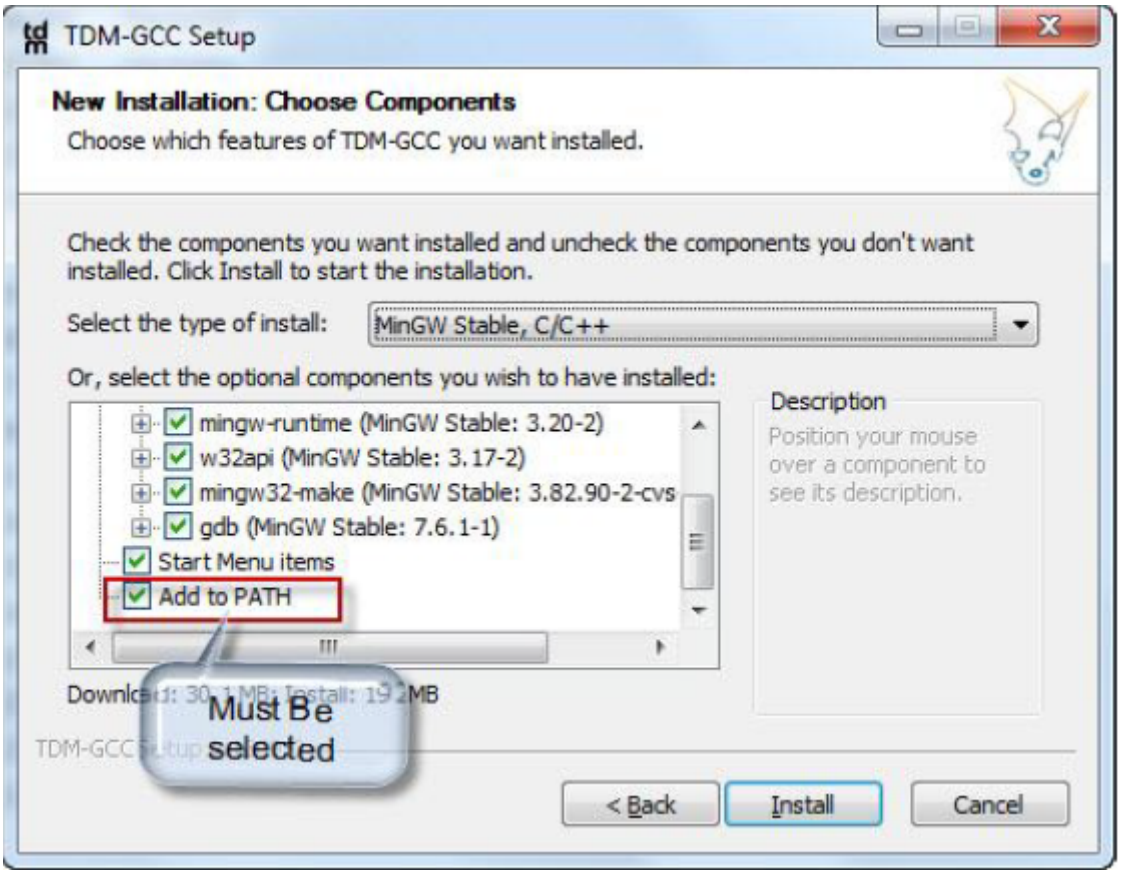
- Select MingW/TDM(32-bit) option and click Next, to get to the following screen.
- 
TDM-GCC Setup
License Changes
How do the licenses of this software affect you?
Hi! Sorry for the interruption, but you may want to take at least a few seconds to look into some recent license changes for the software you're about to install.
Parts of the "winpthreads" library will be compiled into every binary file (EXE or DLL) you create. It's a necessary evil that is currently required in order to provide support for threads and concurrency in programs compiled by GCC.
The license for winpthreads requires you to reproduce its text in every copy or substantial portion of the winpthreads library that you distribute. This means that even if you just want to distribute a single small executable, created with TDM-GCC (or any winpthreads-based GCC release), you must include a copy of that license.
TDM-GCC Setup 1.1309.0
< Back
Next >
Cancel
- Click Next and provide path to install the GCC . GCC has some problems if it is installed in a folder name having space. So it is recommended to install in path like C:\MinGw. Make sure the folder was empty.
- 
TDM-GCC Setup
New Installation: Installation Directory
Choose the installation directory to use.
Setup will install TDM-GCC in the following folder. To install in a different folder, click Browse and select another folder. Click Next to continue.
Installation Directory
C:\MinGW
Browse...
Space available: 17.0GB
TDM-GCC Setup 1.1309.0
< Back
Next >
Cancel
- Click Next

- 
TDM-GCC Setup
New Installation: Download Mirror
Choose the location of a download server.
Please select a download mirror from the following list. For a quicker download, choose a mirror that is geographically close to you.
Select a Mirror
SourceForge Default
[Africa - Cape Town, South Africa] TENET
[Asia - Ishikawa, Japan] JAIST
[Asia - Seoul, Korea] CDNetworks 1
[Asia - Seoul, Korea] CDNetworks 2
[Asia - Taiwan] NCU
[Asia - Tainan, Taiwan] NCHC
[Asia - Almaty, Kazakhstan] SPACE.KZ
TDM-GCC Setup 1.1309.0
< Back
Next >
Cancel

- Click Next and select MingW Stable, C\C++ option as shown in the below image.

- 
TDM-GCC Setup
New Installation: Choose Components
Choose which features of TDM-GCC you want installed.
Select MinGw
Check the components you want installed and uncheck the components you don't want installed. Click Install to start the installation.
Select the type of install:
MinGW Stable, C/C++
Or, select the optional components you wish to have installed:
Components
gcc (MinGW Stable: 4.7.2-1)
binutils (MinGW Stable: 2.23.1-1)
mingw-runtime (MinGW Stable: 3.20-2)
w32api (MinGW Stable: 3.17-2)
mingw32-make (MinGW Stable: 3.82.90-2-cvs
Description
Position your mouse over a component to see its description.
Download: 30.1 MB; Install: 192 MB
TDM-GCC Setup 1.1309.0
< Back
Install
Cancel

- Make sure 'Add to path' option is selected. Click to install.

- 
TDM-GCC Setup
New Installation: Choose Components
Choose which features of TDM-GCC you want installed.
Check the components you want installed and uncheck the components you don't want installed. Click Install to start the installation.
Select the type of install:
MinGW Stable, C/C++
Or, select the optional components you wish to have installed:
mingw-runtime (MinGW Stable: 3.20-2)
w32api (MinGW Stable: 3.17-2)
mingw32-make (MinGW Stable: 3.82.90-2-cvs
gdb (MinGW Stable: 7.6.1-1)
Start Menu items
Add to PATH
Description
Position your mouse over a component to see its description.
Must Be selected
< Back
Install
Cancel